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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 37
Steel Ties on the Huntingdon & Broad Top Mountain R. R. (illustrated)..... 38
Electrolysis of Underground Metal Structures (illustrated) 38
Wooden Box and Coal Cars of 100,000-lbs. Capacity; Southern Pacific Ry. (with two-page plate)..... 42
Book Reviews 43
Garbage Reduction at Columbus, O..... 47
Mining and Metallurgical Exhibits at the Paris Exposition (illustrated) 48
Engineering and Engineers..... 49
The London Convention of the American Society of Civil Engineers 50
EDITORIAL NOTES 44
Electrolysis and its Remedy—Chinese Artillery and Arsenals.—Recent Court Decisions on Stream Pollution.
EDITORIAL:
The Comparative Cost of Rail and Water Transportation in Europe..... 44
LETTERS TO THE EDITOR..... 46
The Street Railway Accident at Tacoma, Wash. (illustrated).—Cross-Sectioning for Computing Earth Work (illustrated).

THE STEAMER "DEUTSCHLAND," of the Hamburg-American Line, which arrives in New York this week, on its first voyage, is the second largest steamer afloat, ranking next to the "Oceanic," of the White Star Line. The steamer has twin-screws, 23 ft. diameter, driven by two quadruple expansion engines aggregating 35,000 HP., and supplied with steam by 12 double-end and 4 single-end Scotch boilers, with 112 furnaces. The crank shafts are 25.2 ins. diameter. There are four large smokestacks, and two steel masts. The first trip was made at an average speed of 22.42 knots per hour, while the "Oceanic" has a record of 20.37 knots per hour for an entire voyage. The leading dimensions of the "Oceanic" and the "Deutschland" are as follows:

	"Oceanic."	"Deutschland."
Length over all	704 ft. 0 ins.	686 ft. 6 ins.
Beam	68 " 6 "	67 " 0 "
Depth	49 " 0 "	44 " 0 "
Draft	26 " 0 "	.....
Tonnage, registered	17,000 tons.	16,000 tons.
Displacement	.....	23,000 "
Power of engines	45,000 HP.	35,000 HP.
Speed, guarantee	.....	23 knots.

THE NEW PROTECTED CRUISERS for the U. S. Navy, to be named the "St. Louis," "Milwaukee" and "Charleston," will be in general similar to the "Brooklyn," but without the "tumble-home" or sloping sides of the latter. They will be of about 9,000 tons displacement, with engines of 20,000-HP. for a 22-mile speed, or 23,000-HP. for 23 miles. The bunkers will hold about 7,000 tons of coal. Light armor will protect the broadside guns, and there will be a heavy protective deck. The main battery will probably consist of 16 6-in. rapid-fire guns, seven on each side, and one each at bow and stern. There will be no turrets, but all the guns will be protected by shields. It is possible that 8-in. or 10-in. guns may be placed at the bow and stern. The Naval Construction Board is preparing the preliminary designs for these vessels, for which Congress has appropriated $8,400,000 for the hulls and machinery alone.

THE ENGLISH SHIPBUILDING INDUSTRY appears to be in a flourishing condition, according to a recent consular report. During the first three months of 1900 the gross tonnage of ships launched was 265,000 tons, of which steamers represented 264,000 tons. There were under construction 1,249,000 tons of steamers and 11,000 tons of sailing vessels, or 1,260,000 tons in all. These figures are exclusive of war ships. A noted increase in the construction of large steamers is reported. At the beginning of the year there were under construction only three steamers of more than 10,000 tons, while now 17 are in course of construction. There are also 4 vessels of 9,000 to 10,000 tons, 2 of 8,000 to 9,000 tons, and 7 of 7,000 to 8,000 tons under construction.

THE VON ZEPPELIN AIR SHIP recently tested at Friedrichshafen (on Lake Constance) in Germany, is 400 ft. long and 37 ft. diameter. The gas bag is divided into 17 compartments, so that injury to one part would not release all the gas. The outer enclosure is covered by a network of aluminum wire and hemp cord. From this are suspended two aluminum boats 235 ft. long, hanging 50 ft. below the airship, side by side. A footbridge connects them. Each boat is equipped with a 15-HP. Daimler gasoline motor, driving a horizontal shaft with a four-bladed screw in front, and a three-bladed one behind. There are four other screws to assist in steering. Two of these are on each side of the gas cylinder, about half way up, one near each end. These screws can be used to impart a sidewise movement to the ship, as well as for steering. Giffard's ship developed 3.6 HP.; that of Renard and Krebs 8.5, and Schwartz's 12. Considering its greater size, 30 HP. is said to be certainly not too much for Von Zeppelin's. On July 1, the airship was towed out of the shed at about 7:30 p. m., and the ballast adjusted to give the suspended boats an even balance. Count von Zeppelin and four other men were in the boats. The craft was released at 8 o'clock, and rose slowly to an altitude of about 1,200 ft. At first it drifted with the wind, but after a few minutes it made some headway. The ship steered perfectly, and maintained itself in an upright position. The ship then descended and rested on the lake. On July 2, at the same time, another ascent was made. When an elevation of about 650 ft. had been attained it was apparent that the ship drifted slightly to the northward, owing to the strength of the air current which it had reached. It then rose a little higher, and described two circles, to show how perfectly it could be manœuvred. According to the press reports the balloon was some 1,500 ft. above the lake, when it was seen to descend rather rapidly, with its bow inclined slightly downward. The forward part of the balloon came in contact with a projecting tree stump and was rent open. The inner balloon was unhurt. It is reported that the machinery did not work as had been expected. The screws were to make 1,200 revolutions a minute, but actually rotated only half as rapidly. It is feared that their diameter was too small also. The side screws did not operate perfectly, and it is considered a mistake to have waited until so late in the day before ascending. The inventor is Count Ferdinand von Zeppelin, of Stuttgart, Germany.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred, July 12, at Cresco, Pa., on the Delaware, Lackawanna & Western R. R. A runaway train, consisting of 40 cars of ice, escaped control on a heavy grade and collided with a wildcat train, killing two men.

FITTING A NEW PROPELLER AT SEA was an interesting and difficult piece of work accomplished by the engineers of the steamer "Border Knight," which arrived in New York July 17, after a voyage from Port Natal. On July 2 the tail shaft broke and the screw propeller went to the bottom of the sea. The thrust shaft was uncoupled and shifted, and the broken tail shaft hauled in. The Chief Engineer, Mr. A. B. Geerie, then made a plug and was lowered over the stern of the vessel, so that as the stern rose out of the water he could fit this into the hole in the stern post. A spare tail shaft was then put in place, knocking out the plug above mentioned. The forehold was then flooded, raising the stern so that the end of the shaft was nearly out of water, and on July 4 a spare propeller was lowered and slipped on the end of the shaft, where it was keyed. An 18-in. nut was then fitted on the end and turned by means of an improvised wrench operated from the deck. The whole operation occupied a little over four days, and the steamer completed the voyage without further trouble.

THE AMERICAN MERCHANT MARINE had an addition of about 417,000 gross tons during the fiscal year closing with June, 1900. The vessels built in the United States and officially numbered during the year aggregate 381,863 gross tons. This record was surpassed in 1874, when 432,725 gross tons were built in the United States and documented. Of the new vessels built during the year, 483 (213,052 gross tons) are steam vessels, 575 (92,625 gross tons) are sail vessels, including barges with sail power, and 76,186 tons are barges and a few canal boats for Canadian trade without power of self-propulsion. The large proportion of steam vessels, 56% of the total, makes this year's addition to the fleet in value and in carrying power superior to the additions in 1874 or of any other year in our history. The most important additions of the year have been the large steel vessels built for the trade of the Great Lakes. They include the "James J. Hill," of 6,025 gross tons, the largest merchant vessel built in the United States during 1900, nine other lake steamers and two steel schooner barges, each of over 5,000 gross tons, and five lake steamships of over 4,000 gross tons. On the seaboard the largest vessel built is the steamship "California," 5,879 gross tons, launched at San Francisco, which will be the pioneer vessel in opening regular steam communication between Hawaii and the United States. No other vessel of 5,000 gross tons or over from the seaboard has been numbered for the year, but six steamships of over 4,000 tons each for the Atlantic coasting trade have been built. The only vessel built during the year exclusively for the foreign trade has been the steamship "Maracaibo," of 1,771 gross tons, for the Red D Line in the Venezuelan trade. The sister steamships "San Juan" and "Ponce," each of 3,503 gross tons, and the "Porto Rico," 1,257 gross tons, are the first maritime results of the annexation of Porto Rico. The steel ship "Edward Sewall," 3,206 gross tons, and the steel bark "Kaiulani," 1,750 gross tons, for the Hawaiian trade, are square-rigged vessels, but eleven schooners, each of over 1,000 gross tons, were constructed for the Atlantic Coast trade. Of 1,058 steam and sail vessels of 305,677 gross tons built and numbered during the year, 1,898 of 185,434 tons were steel, 957 of 119,355 tons were wood and 3 of 888 tons iron. The proportion of steel construction is thus much the greatest in our history. This result is attributable also to the great lakes construction, where of a total of 99,776 gross tons, 95,015 tons, 25 vessels, were steel steam vessels. The numbered construction on the Atlantic seaboard comprised 715 vessels of 160,576 tons, of which 76,344 tons were wood. Numbered construction on the Pacific comprised 37,386 gross tons, and on the Mississippi, Ohio and Western rivers 131 vessels of 7,939 tons.

AN EIGHT-WHEEL, FOUR-CYLINDER COMPOUND locomotive, exhibited at the Paris Exhibition by the Eastern Ry. of France, is representative of a type recently introduced by Mr. F. Salomon, Superintendent of Motive Power, for high speed passenger service. The high pressure cylinders are 13¾ x 25¼ ins., placed under the running board, just in front of the leading driving wheels, and their connecting rods drive the rear pair of wheels. The low pressure cylinders are 21 5-16 x 26 ins., cast with the saddle, and drive the crank axle of the leading drivers. All the cylinders are inclined 5.6%. The connecting and coupling rods are of I section, and have strap ends. The working pressure is 200 lbs., and the receiver pressure is 60 lbs. The boiler has Serve tubes and a total heating surface of 2,233 sq. ft., while the firebox has 27 sq. ft. of grate area. An extension smokebox is used. The driving wheels are 80¾ ins. diameter, with wrought iron centers having forged counterbalances. The valve gear is of the Walschaert type. The truck has heavy plate frames with ouside journals, and a plate spring over each axlebox. The driving springs are underhung. No equalizers are used, and all the springs have the plates normally horizontal. The engines were built at the railway company's shops at Epernay.

NEW LOCOMOTIVE WORKS IN RUSSIA have recently been established by the Hartmann Machine Co., at Lugansk, in southern Russia. Electric power is used, the current being generated by seven dynamos driven by five marine type triple-expansion engines of 150 HP. and two triple-expansion engines of 550 HP. Steam is supplied by eight Gehre water-tube boilers, working at 165 lbs. pressure. In the main shop are 16 motors, mounted on spring frames and running at 850 to 950 revolutions. Two motors, of 18 and 35 HP., are coupled to each main line of shafting, which makes 150 revolutions per minute. Each bay of this shop has a 5-ton electric traveling crane, and there are two similar cranes in the storeroom and the riveting shop. In the erecting shop there are two 30-ton electric traveling cranes and three 4-ton jib cranes for handling cylinders, frames and tender framing. The whole plant is in one great building, with the exception of the office and powerhouse. The buildings are of brick and stone, with steel roofs having large skylight area. They are heated by hot water. Besides the ordinary tracks of the Russian 5-ft. gage, there are shop tracks of 28½ ins. gage. The frame plates are straightened in a rolling press driven by a 40-HP. motor, punched by a machine driven by a 15-HP. motor, and then slotted in piles of eight frames. The Niles Tool Co.'s vertical boring mills are employed for wheel centers, tires, etc., and there is also an American multiple punching machine for cab and tank plates. Hydraulic riveters are used for boiler work, and there is a complete equipment of pneumatic tools. The tool shop system and a large proportion of the tool equipment are from the United States. By the extensive use of labor-saving devices and systematic methods of working, the annual output of 150 locomotives is expected to be made with 1,500 men, while other Russian works of the same capacity employ 2,200 to 2,500.

THE EXCAVATION FOR THE NEW POWER HOUSE of the Manhattan Elevated Ry. at the foot of 74th St., New York city, has been completed and the concrete foundations for the building and machinery are well under way. The structural steel for the building itself is commencing to arrive, and erection will be begun immediately. The first of the eight 8,000-HP. engines contracted for with the Allis Co., of Milwaukee, Wis., is expected to arrive in September.

ELECTRIC TRACTION in the Park Ave. tunnel, and the approaches to the Grand Central Station, New York, is under consideration by the New York Central R. R., and experiments are to be made with various systems. Owing to the very heavy and congested traffic on this four-track line, the electric traction system would have to be continued beyond Mott Haven, 5 miles, so as to avoid blocking traffic in the upper yards by the delays incident to stopping the trains to attach the steam locomotives, couple up brake and steam hose, test the brakes, etc.

THE ADDITIONAL WATER SUPPLY OF CHICAGO, from the new 10-ft. intake tunnel, is now being delivered into the mains, the new pumping station at Central Park Ave. having been put in operation. There are three Worthington engines of 20,000,000 gallons daily capacity, and six Scotch boilers. The tunnel and pumping station were described and illustrated in our issue of Aug. 31, 1899.

STEEL TIES ON THE HUNTINGDON & BROAD TOP MOUNTAIN R. R.

While the day when steel ties will be commercially manufactured or generally used in this country is still a long way ahead, yet it is well that experiments with such ties should be continued in order to determine their average life under actual conditions of traffic, and also to bring out by practical experience the special feature of merit or deficiency in the various designs.

We illustrate herewith a form of steel tie which has been in experimental service on the Huntingdon & Broad Top Mountain R. R., near Huntingdon, Pa., for about six months, carrying traffic of an exceptionally heavy character. This tie is known as the "Chester" tie, and is practically identical with the Columbian and Taylor ties put forward a few years ago. It consists of but three parts, and has no separate pieces for the rail attachments. In general principles it resembles the "bowl" and "plate" ties largely used in India and South America, having two separate pieces to carry the rails, these being connected by the tie-bar, which forms the third piece of the complete tie. The ties may be made of various sizes and weights, but in those now in use on the H. & B. T. M. Ry. the rail bearers are made from ⅝-in. plates of the form shown in Fig. 1, bent to a trough shape, with the inner web shorter than the outer one, the greatest depth being about 4 ins. The width is about 8 ins. on top and 13½ ins. across the bottom. The plates used were the only ones that could be obtained at the time, but for future work it is intended to use plates ¼ × 12 × 18 ins., weighing about 15 lbs.

On the inner side of the rail seat two lugs are punched up, engaging 2 ins. in width of the inner edge of the rail base. Across the trough is a T-shaped slot to receive the tie-bar, which in this case is made from a steel tee, although a special rolled section is proposed for future use. The web of this bar is cut away slightly at the rail seats, and the outer edge of the slot is formed as a lug to hold the outer edge of the rail base. To lay the rail, the trough is shifted inwards along the tie bar to allow of the rail being set with its rail base held by the lug on the bar. The trough is then driven outward until its lugs engage with the inner edge of the rail base. It is claimed that the effect of the traffic and the weight of the ballast against the longer outside legs of the troughs will hold these troughs firmly in place and maintain a good hold on the rails. In Fig. 1, the right-hand trough is thus shifted to allow of the rail being put in place. The joint ties are to be of extra length, with three lugs and two tie-bars, as shown, the rails being spliced by plain angle bars. On light curves or approaches to curves, taper keys may be driven through slots in the vertical web of the tie-bar, against the face of the trough, while rail braces can be bolted to the top of the trough when necessary, as shown in Fig. 2.

The ties on the Huntingdon & Broad Top Mountain R. R. were laid Oct. 12, 1899, and Fig. 3 shows them laid in the track. They are 44 in number, with a normal spacing of 24 ins. c. to c., but the actual spacing varies from 16 to 30 ins., the ties having been put in where wooden ties were removed. Each trough or rail bearer weighs about 25 lbs., and the tie-bar 60 lbs., giving a gross weight of 110 lbs. per tie. The joint ties are not used. The rails weigh 70 lbs. per yd., and are laid with suspended joints, spliced with four-bolt angle bars. The track is ballasted with slag. This track is on a level piece of line, with a curve of 1°. The cost per tie was about 3 cts. per lb., but it is expected that the ties can be made in quantities for $2 or $2.25 each. So far, they have required a trifle more tamping than wooden ties in order to maintain the track in line and surface, but this is the ordinary experience with track newly laid with metal ties. We learn from Mr. Carl M. Gage, General Manager of the Huntingdon & Broad Top Mountain Ry., that since the ties were laid about 1,500,000 tons of freight have passed over them, principally coal in cars of 60,000 and 80,000 lbs. capacity. The trains are hauled by engines of 100 tons weight.

It is claimed that with these steel ties a better and more durable track can be made than with wooden ties, while the labor for track maintenance may be reduced 40% and the length of sections increased 33%, with a resultant financial economy in favor of the steel ties. The Chester tie is being introduced by the Philadelphia Railway Track Equipment Co., 1311 Stephen Girard Building, Philadelphia, Pa., and we are indebted to Mr. Francis S. Pecke, Chief Engineer of the company, for information respecting it.

FIG. 3.—TRACK LAID WITH STEEL TIES; HUNTINGDON & BROAD TOP MOUNTAIN RY.

ELECTROLYSIS OF UNDERGROUND METAL STRUCTURES.*

By Dabney H. Maury.†

Reports of electrolytic injury to water and gas pipes are rapidly accumulating from cities all over the United States, where the single trolley system has been in use for any considerable length of time, and the subject is one of serious moment to every corporation or municipality owning underground metal structures of any sort.

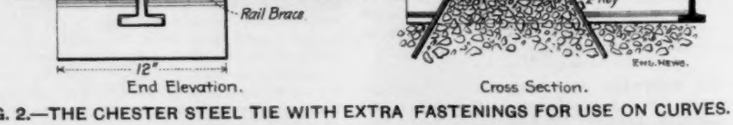

FIG. 2.—THE CHESTER STEEL TIE WITH EXTRA FASTENINGS FOR USE ON CURVES.

It is the purpose of the writer, after illustrating a few of the many instances of electrolytic injury which have come under his notice, to discuss the electrical resistance of the joints of cast-iron mains, and to point out the important bearing which this joint resistance has upon all the various remedies for electrolysis heretofore suggested, and to show, from actual cases, the results which must certainly follow, if cast-iron mains are used to convey electric currents.

The writer has been, since March, 1893, Engineer and Superintendent for the plant now owned and operated by the Peoria Water-Works Co. Early in 1893, the water company's street foreman, Mr. W. B. Norris, reported to the writer that extra strong lead service pipes laid under the street railway tracks were bursting with a frequency that was remarkable, and that the appearance of the burst pipes was unusual, and different from that of any pipes the foreman had yet seen. Electrolysis, as occurring in water and gas pipes, was, at that time, almost unknown and very little had been published, even in engineering papers, regarding it. The writer at once suspected, however, the cause of the breaks, and the foreman was instructed to give him prompt notice of every such break, so that he could personally inspect the pipe and note the circumstance attending its rupture.

In order to better keep track of the injury, printed tags were prepared, as shown by the following:

Size and kind of Pipe.....
Service to No. .... Street.
Length from main to curb .....
Date put in .....
Date repaired .....
Cause of repairs .....
Distance of break from center of Electric Railway tracks..... .....
Distance of main from center of Electric Railway tracks..... .....
Distance of stop at curb from center of Electric Railway tracks..... .....
Condition of Pipe at main.....
Condition of Pipe under tracks.....
Condition of Pipe between tracks and curb.....
Condition of Pipe at curb.....
Remarks .....
.....Inspector.

(The tag shown by Mr. Maury was an ordinary Dennison manila tag, about 3 x 6 ins., with the printed matter given above, but with extra spaces between each of the last six lines.—Ed.)

Whenever a pipe burst, the attendant circumstances were noted on these tags and the tags were signed by the superintendent, the foreman and the men assisting in the work of repairing the pipe. A sample of the pipe was saved for reference and the tag was attached thereto. Although a number of breaks occurred before these records were begun, and in spite of the fact that some intelligent laborers in search of lead for making joints in water mains appropriated and melted down a good many of our carefully preserved samples, records are still on file of 116 electrolytic breaks.

The bursting of service pipes continued with increased frequency, nearly always occurring on those pipes which passed under the railway tracks; for instance, on streets in which the mains were laid on or towards the south side of the railway tracks, 96% of the recorded breaks occurred in service pipes supplying the houses on the north side of the street and in pipes passing under tracks.

In investigating the cause of the destruction of our pipes, the query early suggested itself as to whether chemical action pure and simple could have caused the injury. To make clear the claim that the damage was done by the electric current, it seemed to the writer that some evidence should be found of redeposition of the metal supposed to have been removed from the pipes by the current. Our search for this additional evidence was soon rewarded, for early in March, 1894, we observed in the excavation made to renew a broken service pipe, that the lead taken away from the pipe was deposited in the form of glistening particles, or thin metallic coatings, on soil, sand and gravel, all through the adjacent earth, but above the pipe and in the direction leading from it up to the rails—the pipe at this point being shown by voltmeter tests to be electrically positive to the rails. In one excavation, where there was a well-defined wet streak along a fault in a clayey soil, the lead compound, afterwards identified by chemical analysis as sulphide, was observed along this wet streak as far as the sides of the excavation, or more than 6 ft. from the pipe, the streak leading diagonally up from the pipe to the rails. A similar redeposition of the metal was observed in the case of wrought-iron gas service pipes, and of cast-iron gas and water mains, the joints of the latter being surrounded by

*Slightly condensed from a paper read before the American Water-Works Association at Richmond, Va., May, 1900.

†Consulting Engineer, Engineer Peoria Water-Works Co., Peoria, Ill.

nearly every case by soil stained with oxide of iron, while immediately in front of the ring of lead in the joint would be found a bluish metallic discoloration showing the redeposition of the lead. The writer sent samples of the soil thus impregnated with lead and iron compounds to Messrs. Stone & Webster, Electrical Engineers and Experts, of Boston, and to Engineering News, and to "Fire and Water." The letters accompanying the samples, which were published in Engineering News, March 22, 1894, and in "Fire and Water" of about the same date, were, it is believed, the first published notes of such redeposition of the metals removed from underground pipes by the return street railway currents.

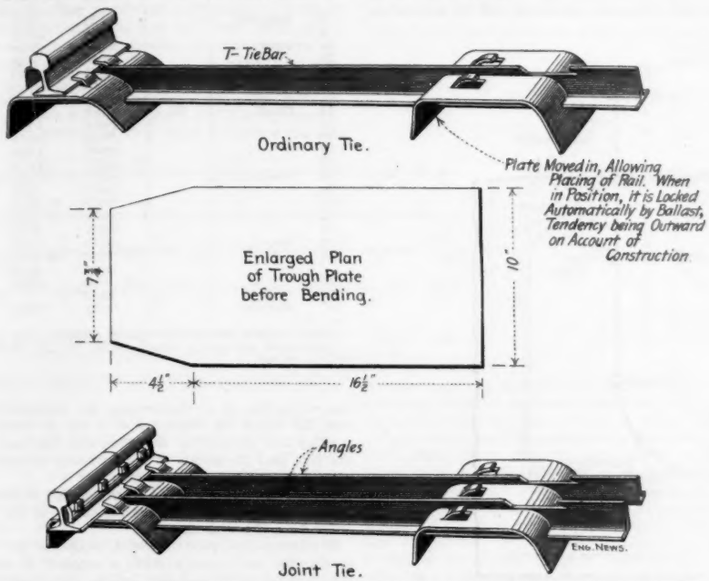

FIG. 1.—THE CHESTER STEEL TIE; HUNTINGDON & BROAD TOP MOUNTAIN R. R.
Philadelphia Railway Track Equipment Co., Makers.

On March 30, 1894, the water company's steel stand-pipe on the West Bluff burst, killing one person and injuring 15 others, one of whom died later from his injuries. Upon examining the wreck of the stand-pipe, the writer at once noticed a peculiar pitting of the inside of the vertical sheets, and the appearance of these pits was so different from that caused by any ordinary oxidation that he was soon almost positive that they were due to electrolytic action. A similar stand-pipe on the East Bluff was drained, and was found to be similarly pitted. The whole inner surface of the vertical shell appeared to be thickly

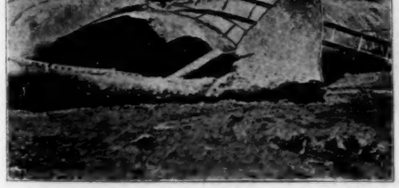

Fig. 1.—View of Wrecked Stand-Pipe at Peoria, Ill., Showing Pitting on Upturned Piece, Due to Electrolysis.

(The two largest blotches are streaks of mud.)

covered with blisters resembling in outward appearance the tubercles sometimes found inside of old cast-iron mains. This blistered covering, which was almost as thin as paper, was composed entirely of oxide of iron, and on brushing it away with the finger tips, the black paint with which the stand-pipe had been originally coated would be found beneath it. The black paint was oftentimes almost unbroken, or, at least, very slightly cracked. When the paint was brushed off, the pit would be disclosed, considerably smaller in area than the surface covered by the blister. The surface of the metal in the pit was perfectly bright and clean and its fiber was clearly discernible. Many of these pits were more than ⅛-in. in depth. They were slightly more numerous in the West Bluff pipe than in the East Bluff stand-pipe and were in both generally larger and deeper on the lower courses of the vertical shell.

Fig. 1 is a photograph of the wrecked stand-pipe, the upturned corner of the torn sheet near the center of the picture showing the pitted appearance of the surface, the blisters having been, of course, shaken off by the fall of the metal and the metal itself having become somewhat oxidized before the photograph was taken. Fig. 2 is from a photograph of a small sample of steel from the stand-pipe and shows the pitting in the sheets around the edges of the rivet heads.

It seemed advisable to secure a thorough expert examination with a view to determining the cause, nature and extent of the observed pittings on the stand-pipes, and injuries to the piping system. Messrs. Stone & Webster, of Boston, were selected to make this examination. The work, in which the writer, from time to time, assisted, covered seven weeks on the ground, and the reports submitted by Messrs. Stone & Webster fully confirmed the suspicions that the pitting was caused by electrolysis and established the fact that the entire piping system of the water company would be endangered by a continuance of the existing electrical conditions. The West Bluff stand-pipe was distant about 60 ft. from the street railway line on Bourland St. The East Bluff stand-pipe was about 700 ft. distant from the railway line on Knoxville Ave. Both stand-pipes were more than a mile from the power station, and were negative to the rails. The electrical examination relative to the stand-pipes was conducted mainly at the East Bluff stand-pipe, which was still in service. A flow of a part of the current from the railway line was clearly traced through the earth to the anchor bolts which held the stand-pipe to its foundation, as shown in Fig. 3, up these bolts and into the steel of the shell, and through the shell and from its inner surface to the projecting section of the 16-in. flanged cast-iron pipe which served as both inlet and outlet, and which connected the stand-pipe to the water mains. The current was then traced along this pipe and along the mains to the power station. The deflections of the volt-meter needle were clearly traced to the railway current, being especially influenced by the one or two cars on the line beyond the stand-pipe on Knoxville Ave., and when the cars stopped running at night, the movement of the needle ceased. Where the current left the inner surface of the shell to pass through the water to the inlet pipe it made the pits already described.

Fig. 4 is from a photograph showing the interior surfaces of three sections of this inlet pipe, marked A, B and C, respectively, the positions occupied by these sections originally being shown by the letters A, B and C in Fig. 3. An examination of the photograph shows the strongly marked and numerous pits which were found inside the sections A and B, while the inner surface of the section C was found to be practically as smooth and perfect as though new. When the condition of the inside of these three sections of pipe was first noted, it seemed hard to understand why A and B should be pitted, while C was unaffected. A closer examination, however, showed that in the flanged joints between the bottom sheet of the stand-pipe and A and B, respectively, corrugated copper gaskets were used, while the pipe B was separated from the pipe C by a thick rubber gasket; and that under the nuts and heads of the bolts holding the flanges together, there were grummets or wrappings of cotton wick soaked in tallow. The result of this arrangement was, that the current which entered A, after passing through the water from the inner side of the shell of the stand-pipe, and which was trying to return along the inlet pipe and water mains to the power station, encountered, at the joint between B and C, the rubber gasket and the grummets. The effect of the gasket and grummets was to practically insulate the section C from the sections A and B, and as none of these pipes were in contact with the ground, the current was compelled to leave the pipes A and B and travel through the water or along the slimy coating of oxide on the inside of the pipes around the joint between B and C, in order to continue on its journey. As the current was not leaving C, this pipe was not injured, but the current, in leaving the inner surfaces of A and B did pit them, as shown in the photograph.

These stand-pipes and the inlet pipes were negative to the rails, and are striking examples of electrolytic pitting under such conditions.

Early in 1898, Professor D. C. Jackson, of the University of Wisconsin, and Messrs. Stone & Webster were requested to supplement the investigations already made by the latter, by another examination of the system, with a view to ascertaining whether the electrical conditions reported in 1894 still existed. The result of all these examinations and of those made, from time to time, by the writer, showed that the differences of potential between mains and rails had increased rather than diminished, while the number of breaks in the service pipes, and the number and extent of pittings in the mains, were very much greater than had before been observed.

With a view to further proving that the injury done to the cast-iron mains and service pipes was caused by the electric current, samples of the graphitic substance dug out from the pits in the mains, and of the scale or incrustation adhering to the mains over the pits, and of the soils at various distances from the mains, and similar samples taken from the neighborhood of the lead service pipes, were sent to the University of Illinois, where they were analyzed by Prof. Arthur D. Palmer. Samples of ordinary soils, unimpregnated by the metallic compounds from the pipes, were also analyzed. These analyses showed that there was nothing in the soil which, except for the action induced by the electric current, could injure the pipes, while all of the conditions, as found by chemical analysis of all the samples submitted to Professor Palmer, were exactly such as would be caused by the presence of the currents complained of.

In 1899, a series of tests were made by Mr. A. A. Knudson, Electrical Engineer, of New York, in conjunction with the writer, at the site of the fallen West Bluff stand-pipe, in order to still further prove that when that stand-pipe was in service, there was an actual flow of current in the manner already shown by the previous tests at the East Bluff stand-pipe, by Messrs. Stone & Webster. The anchor bolts were still in the foundations, but the shell of the stand-pipe, as well as the 16-in. inlet pipe leading thereto, had been removed. It was necessary, therefore, in order to reproduce, to some extent, the actual

Fig. 2.—View of Fragment of Peoria Stand-Pipe, Showing Pitting Around Edges of Rivet Heads.

electrical conditions that had previously existed, to connect a wire from the ends of the anchor bolts to the 16-in. water main in front of the stand-pipe. By connecting in a volt-meter on this wire, the variations of potential between anchor bolts and the water main were observed, and by replacing the voltmeter by an ammeter, the actual flow of current was measured. This current was clearly and positively identified as caused by the street railways, and the result of these tests fully confirmed the statement in the reports of Messrs. Stone & Webster, that the pits in the shell of the stand-pipes had been caused by the street railway current.

The joints of cast-iron water mains often offer, as already stated, considerable resistance to the passage of the

electric current, and the reason for this resistance is apparent, when the construction of these joints is studied. Cast-iron water pipes are coated inside and outside with a preparation of coal tar that is an insulating material. In making a lead joint, the spigot end of one pipe is inserted in the bell end of another pipe and pressed home until it touches the shoulder in the bell. The spigot pipe is centered carefully, so that the annular space designed to hold the yarn and lead may be of equal width all around. The yarn is then rammed in home against the shoulder and holds the spigot in the center of the bell. There can thus be no actual contact between the two pipes, except

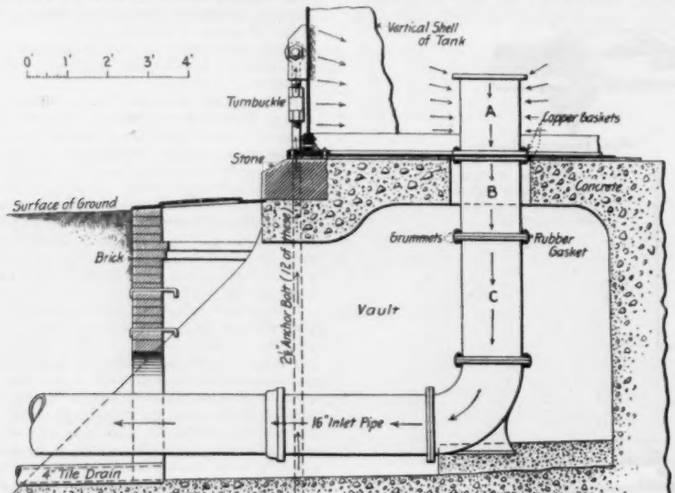

FIG. 3.—PARTIAL VERTICAL SECTION OF PEORIA STAND-PIPE, SHOWING COURSE OF ELECTRIC CURRENT.

where the very end of the spigot abuts against the shoulder of the bell. As both spigot end and shoulder are simply rough castings and are not turned, it follows that they are rarely in mechanical contact at more than two points, and on curves they can only touch at one point. In fact, it is frequently true that after the spigot pipe is once shoved home against the shoulder of the bell, and then released, it works away in the subsequent handling and yarning and oftentimes is not in contact with the bell at all. Even if the two pipes were in actual mechanical contact, the electrical contact would be poor, by reason of the two intervening coatings of tar or asphalt. In that portion of the joint occupied by the yarn, there is no contact between the two pipes and they are at this point fairly well insulated by the yarn itself, as well as by the two coatings. The rest of the joint is filled with lead, which is a conductor of electricity, but in between the ring of lead and the bell outside of the lead and between the lead and the spigot on the inside, are the two tar coatings which materially interfere with the electrical contact between the two pipes.

As it had been stated that the tar coating is completely consumed and burnt out by the heat of the molten lead when a joint is poured, the writer caused a joint to be poured and calked in the usual manner, and then had the bell sawed into three pieces, so that it could be taken off the spigot. It is needless to tell men who have had experience in laying and taking up water mains, that the inner surface of the bell showed that the coating was entirely unimpaired by the heat.

Measurements were made by the writer in 1898 to determine the amount of resistance offered by the joints in cast-iron water pipes, and also to ascertain whether the pipes themselves showed any pitting as a result of this resistance.

A large number of these examinations were made during 1898 and 1899, and in every case the pipe which was of the higher potential was found pitted near the joint, while the pipe of lower potential, or that into which the current was flowing from the other pipe, showed much less electrolytic injury.

To further test the joint resistance and to determine, if possible, the influence of different methods of calking as affecting this resistance, the writer, in conjunction with Professor Jackson, caused a line of 6 and 4-in. pipe to be laid and supported on wooden blocks, so as to insulate it from the ground, as shown in Fig. 5. There were 27 joints in all. The pipe was new and had not been previously used. The calker was instructed to drive up the lead hard in one-third of the joints and to calk these joints in every way in the best possible manner, just as though the pipes were expected to stand the heavy pressure of the Peoria Water-works Co.'s system. Another third of the joints was calked not quite so hard, while the remainder were purposely only lightly driven up, the work being done as though carelessly, or by a bungler. A current of known strength was passed through the pipes, and the drop of potential around the joints was measured at points 1 ft. apart, and was compared with the drop of potential in lengths of 1 ft. of continuous pipe. These measurements were made at different times; first by Professor Jackson and the writer; then by the writer alone, and later by Mr. Knudson and the writer. The resistance of the joint was found, as shown by the table, to be from a few times to several thousand times that of the same length of continuous pipe, and this joint resistance was in no way affected by the manner in which the lead was driven up in the joint, some of the joints on which the best calking was done showing the highest resistance. The usual depth of lead in a joint in a cast-iron pipe is about 2½ ins., but assuming the length of the joint at 4 ins., the joints in this line offered 89.2% of the total resistance of the whole line, or on the average the resistance of a joint was 227 times the resistance of 4 ins. of plain pipe. In making this calculation due allowance has been made for the fact that the points of measurement around the joint were 1 ft. and not 4 ins. apart.

Results of Tests of Electrolyses on Experimental Line of Cast-iron Pipe Under Various Conditions.

No. of joint.	Calking.	Current in amperes.	Drop of potential around joint in volts.* Pipe dry.	Pipe full of water. Clear.	Pipe full of water. Muddy
1	Good....		0.0056	0.0091	0.0087
2	"		.0039	.0050	.0048
3	"		.0046	.0066	.0059
4	"		.0095	.0134	.0122
5	"		.0042	.0070	.0058
6	Medium.		.0080	.0140	.0124
7	Good....		.0124	Off scale, hard.	Off scale, hard.[1]
8	Medium.		.0034	.0050	.0044
9	"		.0069	.0145	.0153
10	Poor....		.0022	.0038	.0033
11	"		.0016	.0028	.0022
12	"		.0041	.0063	.0049
13	Medium.		Off scale, hard.[2]	Off scale, hard.[3]	Off scale, hard.[4]
14	Good....	10	.0108	.0143	.0099
15	"		.0084	.0118	.0088
16	"		.0026	.0031	.0022
17	"		.0006	.0006	.0004
18	"		.0021	.0026	.0023
19	Medium.		.0007	.0009	.0006
20	"		.0017	.0020	.0013
21	"		.0057	.0055	.0046
22	"		.0054	.0058	.0049
23	"		.0011	.0013	.0012
24	Poor....		.0142	.0125	.0115
25	"		Off scale, hard.[5]	Off scale, hard.[6]	Off scale, hard.[4]
26	"		Off scale, hard.[7]	.0093	.0089
27	Medium.		.0016	.0010	.0007

*Nine inches between points of contact.
Voltmeter showed: [1]0.042, [2]0.50, [3]0.520, [4]0.270, [5]0.370, [6]0.315, [7]0.040.

In Kansas City, Prof. Lucien I. Blake, of the University of Kansas, has recently made a number of tests of the joint resistance in cast-iron mains. He found the joint resistance in three lengths of 6-in. pipe to be about 96% of the total resistance of the pipe and joints together; the joint resistance in the 58 joints of 687 ft. of 6-in. pipe which had been 13 years in service, was found to be 96.2% of the entire resistance of the line; the joint resistance of 38 joints in 399 ft. of 20-in. pipe was 88.2% of the total resistance of the line; and the joint resistance in 400 ft. of 36-in. pipe was found to be 96.7% of the total resistance of the entire line.

Mr. Knudson found in Albany a pipe joint which showed a resistance 1,000 times greater than the resistance of an equal length of the plain pipe.

The injury caused by resistance at the joints is not so rapid at any one spot as the injury where the current leaves the pipe for the rails in the positive area, only because all of the current carried by the pipe does not flow around the joint. But one ampere of current, leaving the pipe for the powerhouse in the positive area, pits the pipe but once at that point; while one ampere of current flowing along the pipe and around joints in either the positive or negative district, pits each length of pipe near every joint, where it leaves it to flow around the joint; so that the total injury caused by this ampere is cumulative, and may be, in the aggregate, hundreds of times as great as the damage caused by the same ampere of current where it permanently leaves the pipe.

The effect of the current on the rail joints of a single trolley system is similar to that on the joints in the water mains. Within the past three years the writer has examined many hundreds of rail joints, and it was always easy to tell from the appearance of the rail ends, and of the chairs, when the rails were laid on chairs, which way the current was flowing. The end of that rail which was next to the power station would show little or no injury, while

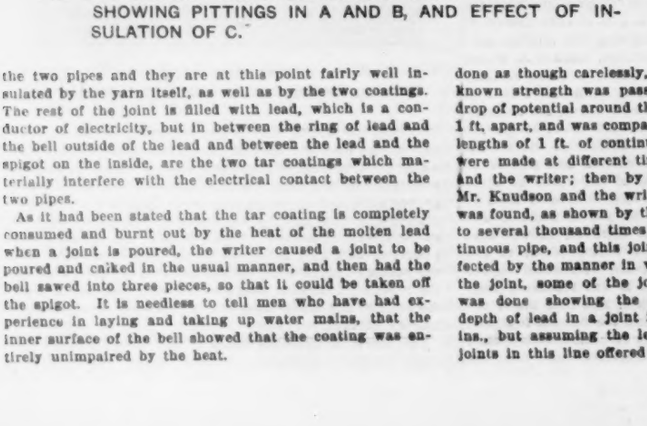

FIG. 4.—INTERIOR VIEW OF LENGTHS OF INLET TO STAND-PIPE, SHOWING PITTINGS IN A AND B, AND EFFECT OF INSULATION OF C.

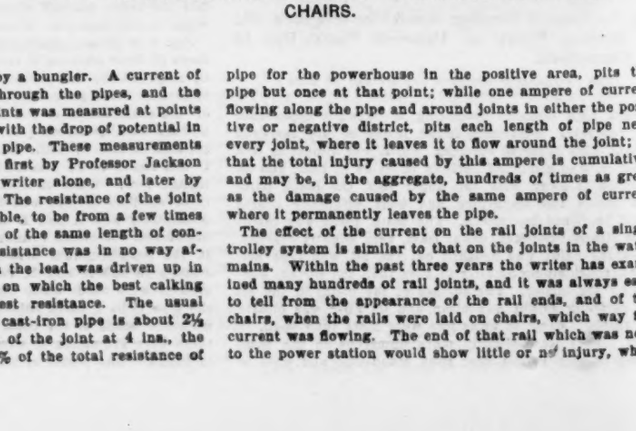

FIG. 7.—VIEWS SHOWING EFFECT OF ELECTROLYSIS ON RAIL CHAIRS.

the end of the other rail, or that having the higher potential, was invariably pitted. Fig. 6 is reproduced from tracings from the bottom flange or base of such a rail (and also from two rail chairs), the solid line showing the shape when the tracing was made, while the dotted line shows the original shape of the rail when it was new and before it had been eaten away by the current. Fig. 6 also shows the bottom portions of two rail chairs. The chair B was taken from the side of the joint away from the power station. The dotted lines show its original shape. The chair C came from the other end of the same rail, on the negative side of the joint, and shows no perceptible injury.

Fig. 7 shows two rail chairs and a fragment of a third chair secured by Mr. Knudson and the writer. The chair, A, was a sample of a large number of similar chairs on the high potential side of the joint, and its thin and wasted appearance is plainly shown. The fragment, B, was broken by hand from another similar chair. The chair at C was from the same piece of roadbed, and is a fair sample of a number of chairs observed near the low potential

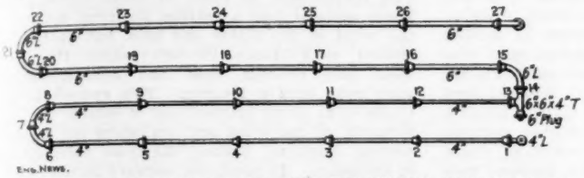

FIG. 5.—ARRANGEMENT OF PIPE TO SHOW RELATION OF VARIOUS CONDITIONS TO ELECTROLYSIS.

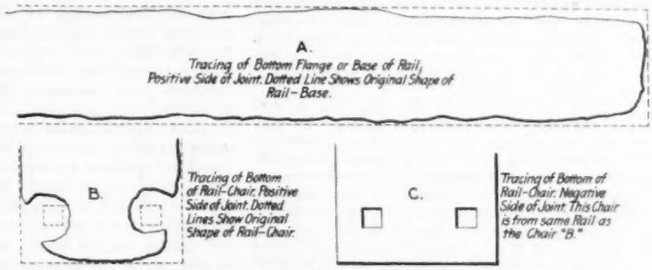
A.
Tracing of Bottom Flange or Base of Rail, Positive Side of Joint. Dotted Line Shows Original Shape of Rail-Base.
B.
Tracing of Bottom of Rail-Chair, Positive Side of Joint. Dotted Lines Show Original Shape of Rail-Chair.
C.
Tracing of Bottom of Rail-Chair, Negative Side of Joint. This Chair is from same Rail as the Chair "B."

FIG. 6.—BASES OF RAILS AND RAIL CHAIRS EATEN AWAY BY ELECTROLYSIS.

side of the joint. This chair, as the view shows, is almost as good as new.

The soil around the outside of a water main offering an easier path for a current than the water or slime on the inside, outside pittings are more numerous and generally deeper, and they are much more easily observed. The pits on the outside may be caused either by current which leaves one length of pipe to go around a joint into the next length of pipe; or by current permanently leaving the main for some other conductor of lower potential, such as rails, or wires leading to the dynamo; but the inside pits cannot be caused by anything except resistance in the line of pipes itself at the joints, as nothing else could make the current leave the metal of the pipe and travel through the water.

Opportunities for observing these pits have hertofore been rare, as the action is naturally slower inside the pipe than outside, and as it is necessary for some one familiar with the effect of electrolysis to be present and actually examine the pipe at the time when it is removed in order that the pits may be identified.

The pittings in the 16-in. inlet pipe to the West Bluff stand-pipe, observed in March, 1894, and inside pittings found by the writer in a 20-in. cast-iron main in 1896, are believed to be the earliest examples of this injury noted, but numerous instances have since been reported.

Figure 8 shows a joint of a 12-in. cast-iron main on which the current was flowing from A to B. The very serious outside pittings, nearly ½-in. in depth, are plainly shown on the pipe A, while the pipe B, on the other side

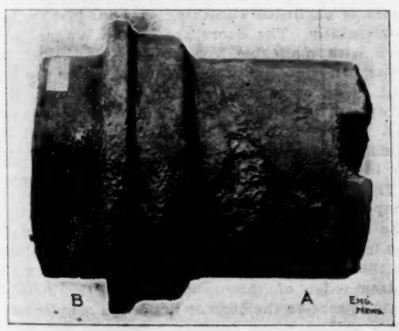

Fig. 8.—Electrolytical Pittings on 12-in. Cast-Iron Water Main.
(Current flowing from A to B.)

of the joint, was, near the joint, almost uninjured. The surface of the lead in this joint was deeply pitted in places and so much of the metal had been removed that the marks of the calking tool all around the joint were entirely obliterated. The pipe A was also pitted in a number of places on the inside, while no pits were found on the inner surface of the pipe B near this joint.

Mr. A. A. Knudson found deep outside and inside pittings in Albany, in 1899, as shown in the view, Fig. 9.

Professor Blake, from recent examinations in Kansas City, writes as follows:

A 12-in. pipe running at right angles to an electric railway, and which was negative to the rails, was found to be carrying a current of varying strength and delivering it into a 36-in. main some 750 ft. distant.

Electrolytic pittings were found on many sections near the joints, only on the positive side, where the current was shunted around the joints. Some of the pittings were ½-in. deep. The interior of the pipe could not be examined.

Again, a length of 6-in. cast-iron main was taken up in another part of the city and internal electrolytic effects were apparent near the joint. A chemical analysis of the material dug from the pits gave 22.3% graphite, 49.7% iron.

A second length was removed and broken into, and a fresh fracture revealed the internal electrolysis, by the discoloration of the iron where the pitting was taking place, and which was already ½-in. deep, beginning from the inside. A number of similar cases were discovered, and are convincing proof that cast-iron mains cannot convey currents without electrolytic damage, when those mains form part of the return circuits of electric railways.

Within the past few months the writer had occasion to remove from the ground a 16-in. cast-iron main. This main was negative to the rails and was nearly two miles from the power station. It lay at right angles to the tracks, and the portion removed was distant, at its nearest point, about 150 ft. from the rails, and at its further end, 570 ft. from the rails, there being 420 ft. of pipe removed. Measurements with volt-meter and ammeter showed a current flowing along this pipe from the rails towards the wet soil of the river bank, in which the further end of the pipe was buried. Every length of pipe showed electrolytic injury. In one pipe the bead in the spigot end had been eaten off for two-thirds of the circumference of the pipe, and in one place the entire thickness of the pipe was eaten out for nearly an inch in depth from the end. There were both outside and inside joint pittings, always on the positive side of the joint, and no pits at all could be found anywhere else on this pipe.

In a recent paper, Professor Blake states that observations and experiments prove that the effects of electrolysis upon water pipes are not limited to the so-called "danger areas," or districts in which the pipes are electrically positive to the rails. He goes on to say:

Resistance at the joints in cast-iron pipe is sufficient at most joints to shunt a portion of any current allowed in these mains, around the joints through the soil outside or water inside, or through both. Then on the positive side of joints, the effects of electrolysis, both external and internal, are to be apprehended.

Professor Blake then gives in detail the tests previously referred to as made by him to determine the joint resistance, and closes by giving the forcible and convincing examples already quoted of the disastrous results of allowing cast-iron mains to convey electric currents.

It must be clear to any one who has seen the evidence of injury caused by the return currents, and who has studied the effects on the water mains at the joints, or at any other point where the current, once on the pipe, must leave it, that the owners of such pipes can do nothing to prevent the injury.

Street railway companies have frequently recommended that the pipes themselves be connected by wires to the negative bus-bar of the generator, or to the rails at various points, or to overhead or underground return feeder wires—thus diminishing the resistance of the pipe system as a conductor, and lowering the potential of the pipes usually in what has been termed the "danger district" or the region where the pipes are shown by volt-meter to be positive to the rails. But all such methods contemplate using the pipes to convey the electric current, and they all invite more current to the pipes at some part of the system.

It would undoubtedly be a fine thing for the railway companies to have the conductivity of the pipes on which they already rely largely for the return of their current, still further increased. It would mean smaller coal bills in the power station and less outlay for construction and maintenance of their own return circuit. It would, also, apparently lessen the rapidity of injury to the pipes in the "danger district," and, by stopping temporarily the number of actual breaks at the points where they have been occurring with greatest frequency, it would stave off the day of reckoning with the pipe owners. But the general pipe system would be carrying much more current, and, as the pitting goes on, at or near the joints, wherever a main is carrying current, either in the positive or negative district, it would mean that, while the injury in the "danger district" would not be so rapid, the whole system would be much more generally attacked, and that by the time a bursting pipe at length called attention to the injury at some point remote from the power station, the entire pipe system would have been seriously injured. Equally impracticable and misleading are the suggestions for maintaining the pipe system at equal potential throughout, and for "insulating sections" or "insulating joints," some of which have been patented. The idea of these sections or joints, as advanced by their advocates, is to break up the metallic continuity of the pipe line and reduce its conductivity, and thus prevent its serving as a path which the return current would naturally choose. The effect of thus dividing a pipe system into a small number of sections would hardly be worth considering, as the ground itself is a good conductor, and the current would leave one section only to go to another, passing through the earth around the insulating joint just as it does around the lead joint in a cast-iron main. To entirely destroy the conductivity of the pipe line, it would be practically necessary to make it up entirely of insulating sections, which, as non-metallic substances are not generally recognized as good material for underground water pipes, and for other equally obvious reasons, would be absurd. The conductivity of the tracks may be, of course, increased by the use of heavier rails, heavier bond wires and improved methods of bonding, or by the introduction of welded joints, or by making practically continuous rails; but the continuous rail itself is at best but a palliative of the electrolytic injury. The rails are not insulated from the ground, and the pipes would still carry, and be affected by, a large portion of the current, as is clearly shown by numerous electrical surveys and reports of serious damage in cities where the best tracks known to modern science are in use.

What, then, can be done to entirely remove the cause of the injury? The answer is simple. Keep the return currents out of the ground.

This has been successfully accomplished in this country for years, by two methods. In Cincinnati, and in Washington, D. C., the double overhead trolley is in use, while New York and Washington have been the first to adopt

Fig. 9.—Electrolytical Pittings on Inside and Outside of 4-in. Cast-Iron Water Pipe, Albany, N. Y.

the conduit system. In this system, both the outgoing and the return conducting wires are laid in a conduit under ground, electric connection with the motors in the car being furnished by two contact pieces or "plows" running under the car in a slot resembling that of the old cable roads. The supply wire, as well as the return wire in the conduit, is carried on insulated supports. Both the overhead and underground systems have proven successful in practice, not only in entirely preventing electrolysis, but in what is naturally of far more importance to the street car companies, in the general economical details of operation and maintenance. The conduit system

is, of course, more expensive to build, and is peculiarly adapted to the larger cities.

The Cincinnati overhead double trolley system comprises about 220 miles of track. The conditions of its operation are unusually trying, among them being narrow streets, grades sometimes as high as 12½%, and, in places, especially near Government Square, a multiplicity of intersecting tracks such as is, perhaps, not equalled in street railway construction anywhere else in this country. Every car on the system, at some time in its regular trip, must pass over one of the tracks at Government Square, and to stand during the busy hours and watch the perfect ease and smoothness with which the hundreds of cars thread this maze of tracks, at times at intervals of only four or five seconds, is always most interesting, and will convince even a skeptic of the mechanical practicability and success of the double overhead trolley. After ten years' experience with this system, which has been voluntarily adopted and developed, its owners and managers declare that the cost of operation and maintenance is less than it would be with single trolley.

The double trolley is safer than the single and the difference in appearance between them is trifling. All connections are in plain sight overhead, and are always accessible for repairs. No lightning arresters are needed. No excavation of street or pavement is required to renew rail bonds, as the rail bonds themselves are no longer needed; while for hill climbing, in bad weather, the double trolley is far more efficient, since both rails may be sanded, while in the single-trolley system, one rail must be kept clean, in order to keep electric contact between wheel and rail, thus diminishing the frictional grip of the wheel on that rail, while the sanded rail is, at the same time, nearly useless as a conductor.

In Washington, D. C., all roads within the city limits are required by law to have a complete insulated underground metallic return for their current, and by recent acts of Congress, passed on account of electrolytic injury caused by the single trolley systems, the overhead double trolley is required in all other new or amended charters, within the District of Columbia.

In systems recently constructed in London, the double trolley is required by law, and the cars are accordingly running under that system.

The cost of changing a street railway system from the single to the double trolley is so small as to be insignificant when compared with the enormous interests endangered by the continued use of the single-trolley system.

WOODEN BOX CARS AND COAL CARS OF 100,000 LBS CAPACITY; SOUTHERN PACIFIC RY.

(With two-page plate.)

While gondola cars of 80,000 to 100,000 lbs. carrying capacity are now so common as to attract but little attention, box cars of more than 60,000 lbs. carrying capacity are still quite exceptional, largely for the reason that box cars (carrying ordinary freight) are less frequently loaded to their full capacity than cars carrying coal and ore. We illustrate herewith, however, box and gondola cars of 100,000 lbs. capacity, 1,700 of the former and 300 of the latter of which have been put in service by the Southern Pacific Ry. These cars are notable not solely on account of their great carrying capacity, but also from the fact that although they are of wooden construction, their dead weight is extremely light for cars of such capacity. A special feature of the construction of the cars is that no mortise and tenon work is employed, the parts being put together with malleable and wrought iron fittings. Ample strength and durability are claimed for the design. The box cars weigh 33,398 lbs., which is about the average of ordinary box cars of 60,000 lbs. capacity, although some recent box cars of this capacity weigh but 30,000 lbs., owing probably to more careful design. The coal cars weigh 32,868 lbs., while steel cars of the same capacity, described in our issue of Jan. 19, 1899, weigh 34,000 lbs. The steel cars, however, are 6 ft. 6 ins. shorter than the wooden cars of the Southern Pacific Ry.

The cars in question were built under direct orders from Mr. C. P. Huntington, President of the Southern Pacific Ry., who wished cars built of wood with trussed members, in order that the dead weight might be kept as low as possible. The cars were designed by Mr. F. E. Canda, 11 Pine St., New York, N. Y., who has taken out patents covering the features of construction. They were built by the American Car & Foundry Co., at its shops at Huntington, W. Va., and we are indebted to Mr. W. J. McBride, General Manager of the company, at St. Louis, Mo., and to Mr. E. Ensign, District Manager, at Huntington, W. Va., for blue prints and other information.

The selection of the material for these cars was made after careful consideration of the structural possibilities of all the materials available for that purpose. Mr. Canda selected wood, malleable and wrought iron and cast steel, because he believed, upon careful consideration and detailed calculations, that for a given weight a stronger structure could be built with these materials. Various experiments within the past few years upon the strength of materials relative to their weights are claimed to show that he was correct in the selection, and the most exhaustive of these experiments are said to be those conducted by Prof. R. H. Thurston, president of the Sibley College of Engineering at Cornell University. The problem before the designer in this case was to avail himself of the stiffness and strength of wood, and to avoid the weakness usually found in all methods for fastening the timbers together. Malleable iron, from the ease with which it can be worked into the most intricate forms, as well as from its great strength, is an almost ideal material for making strong and permanent joints between members of wood. This, with iron and steel connections and tension members, made it possible to build a car in which there are neither mortises nor tenons in the frame, and in which no strain is put upon the side grain of the timber. This relieves the wood from pressure in directions where it is notoriously weak, and prevents shrinkage from causing weakness. By reference to the engravings, it will be seen that the sills, posts, braces and plates are not cut by mortises at any points, and are only bored for the bolts and rods. As nearly all the rods are double, the holes are proportionately small in size. The use of pressed steel has been avoided, as the designer believes that no advantage arises from its use, and that its place can generally be taken more cheaply and to better advantage by wrought or malleable iron or cast steel. Wherever wrought iron has been introduced in these cars, the forgings are carefully annealed in order to remove internal strains.

Box Cars.

The 100,000-lb. box cars, Fig. 1, are not of very exceptional size, owing to the nature of the principal freight which they are to carry, which consists of sugar and wheat in sacks. The framing, however, has been designed with special reference to the materials employed and to the enormous strains which 50-ton loads impose upon all the principal members of the car. There are six lines of longitudinal sills, the ends of which are fitted with caps driven upon them and forming pockets against which, or into which, the end sills fit. The end sills are built up of three timbers and two horizontal 5-16-in. steel plates, which bear against the sill pockets and against which bear the washers of the truss rods, thus relieving the timber from pressure against the side of the grain. The center sills are fitted with sub-sills which are continuous from bolster to bolster, and are held firmly by the bolster polkets. Four sub-sills extend from the bolsters out to the ends of the car, and being firmly bolted to the sills take all the buffing and drawing strains directly. These sub-sills are claimed very nearly to double the vertical stiffness of the center sills.

The floor frame is completed by six lines of truss rods which pass under struts bearing against the needle beams. An interesting feature of these truss rods, made necessary by the enormous load to be provided for, is the fact that collars are forged on the rods to prevent the saddles from being thrust together by the strains. The transoms, or needle beams, are 4½ × 7½ ins., 9 ft. 8 ins. apart, c. to c., and as these are below the sub-sills they support the intermediate and side sills by malleable iron blocks or distance pieces. The total truss depth is 33 ins. Directly over the needle beams is a line of filling planks 1¼ × 9 ins., with a ⅝-in. rod passing through the sills. The body bolsters are of cast steel of the "American" pattern, made by the American Steel Foundry Co., of St. Louis, Mo.

On this floor framing the body of the car is erected. As the sides are 7 ft. 2½ ins. high, sufficient depth is provided in which to design a truss of ample strength to carry the load. In designing this truss, which can be made light as well as strong, a feature has been introduced which is said to be entirely novel in car building. The truss is designed and set up with an initial camber, which amounts to 1⅛ ins. between the bolsters. The side is divided into nine panels, two of which extend from the bolsters to the ends of the car, and three are placed on each side of the door, the spaces for the doors forming the center panels. The posts and braces are made uniform 2½ ins. in thickness. The braces, however, vary in width from 4 ins. on each side of the doors to 7¼ ins. at the bolsters, their width being proportioned to the strains which they have to transmit. The posts are placed between pairs of tie-rods, and their fittings at top and bottom are designed to relieve the main members from side strain and to secure a perfect transmission of the strains from point to point without compressing the side grain of the wood. Each post and brace is fitted at both top and bottom with a malleable iron pocket held in place by small dowel pins. These pockets take a bearing, however, not upon the wood of the plates and sills, but upon pipe sleeves or bushings through which the vertical iron tie-rods pass and against which their nuts take a bearing. This system is introduced at every intersection; it retains the full strength of the wood and transmits the strains without crippling, making the truss independent of shrinkage. To resist the outward thrust of the load the tie-rods are curved outwards, forming a truss in the sides of the posts. In setting up the car the panels measure more over the plates than on the sills, therefore all the braces are cut to a uniform length, giving the frame the desired camber when set up, so that the truss rods have no initial strain when the car leaves the erecting shop. The ends are framed in the same way.

The roof framing consists of carlines 9¼ ins. deep and 1½ to 2 ins. thick, spaced 3 ft. 2⅛ ins. apart. To the end of each carline is bolted a strap, the end of which is turned and threaded passing through the side plates and drawn up by a nut. The carlines carry seven roof timbers, six of which are 1¾ × 2 ins., while the middle one is 2½ × 3½ ins. Across these again are sticks 1¼ × 2½ ins., carrying longitudinal strips 1¼ × 2 ins., to which are nailed the roof planks. Corrugated metal sheathing is laid over the roof timbers, with the ends let into the 1¼ × 2½ ins. cross pieces, and metal flashing is laid on these cross pieces and bent over so as to shed any moisture onto the sheathing. The roof construction is on the Winslow system.

The floor is of 1¾-in. planking. The side sheathing is of vertical planks ¾-in. thick, with facia board and letter board outside at the top. Between the posts is a line of blocking pieces, 2¼ × 2½ ins., and a girth or belt rail 3¼ × 3½ ins., whose top is 5 ft. above the floor. Below this belt there is an inside sheathing of 1-in. planks, laid horizontally. The doors are of the Wagner pattern with malleable iron hangers and other fittings. In each end of the car, just above the belt rail, is an opening 6 × 24 ins., faced with iron straps on the edges. This is for loading planks, etc. The ends of the running board project beyond the eaves of the car body, and are supported by iron brackets.

The cars are fitted with air brakes, M. C. B. couplers, and the Canda drawbar attachments. The malleable iron buffer blocks are secured by the truss rods to a timber 4 × 9¼ ins., 33 ins. long, on the face of the end sill. An angle iron on the bottom edge of this timber forms the striking plate to receive the horn or lug of the coupler head when driven home forcibly. There is the usual arrangement of hand brake-wheel and shaft, with ladder irons on the sides and grab irons on the ends of the car.

Coal Cars.

The 100,000-lb. coal cars, Fig. 2, are deep double-hopper cars, with horizontal drop doors. The main framing consists of two side sills and two center sills, framed into end sills and trussed by four heavy rods. As only four sills can be used in such cars, it is necessary to distribute the load by means of cross trusses to the sides of the car in order to carry it successfully. The leading departure in this design from that generally employed is in the introduction of the side truss to carry the load. As the sides for cars of this capacity have to be over 6 ft. high there is ample room for the introduction of a well-designed truss

to the floor frame the leading features of the box car, above described, have been retained: Sub-sills 5 ins. deep reinforce the 9-in. center sills, as the latter cars. Under these sills at the center of the car a deep cross truss is introduced, formed by means of a compression member on top of the sill and a pair of 1⅛-in. rods. This truss distributes the central load to the side sills. There are eight central panels with one at each end beyond the bolster. The braces and posts are 3½ ins. thick, and the braces vary in width from 2½ ins. at the center to 7 ins. at the bolsters. The framing of these cars is laid out in the same manner as that of the box car. All the truss rods have enlarged ends and the struts resting on them are in every case held in place by collars forged on the rods. The outward thrust of the load in the coal cars, as in the others, is resisted by bending the tie-rods out, and in this case saddles on the posts carry the rods. The details of the posts and braces, and of the pockets to carry the ends of the large timbers are the same as in the box cars.

In consequence of the location of the hopper, the truss rods are not in a direct line, and they are coupled to the looped ends of flat bars ⅝ × 2 ins., which pass under the hopper. Cross timbers, 7¼ × 9 ins., are fitted between the sills at each end of the hopper and are reinforced by ¾-in. rods which pass through the sills. The framing is also trussed laterally at the middle of the car by two rods 1⅛ ins. diameter, with 1¼-in. ends. Two short intermediate sills, 3½ × 9 ins., extend from the end sills to the cross timbers, and are supplemented by two ⅞-in. rods with 1-in. ends. Cast steel body bolsters are used, and the draft timbers are below the center sills, with sub-sills between the bolsters, as in the box cars already described. The posts and braces are fitted with malleable angle iron blocks, and vertical rods extend the full truss depth, passing through pipe sleeves in the sills and top timbers. These top timbers are 7 × 4½ ins., with a steel plate 3-16 × 4½ ins., secured by straps.

Across the top are three timbers 3 × 5 ins., with 3-16-in. steel plates on top, the ends being bent over the side posts and bolted, while strap bolts are secured to the bottoms of the timbers. The outer ends of the hoppers are supported by cross timbers 3 × 6 ins., under each of which is a ¾-in. rod extending through the side posts. The sides are still further supported by three inside arch ties of T-irons 1¼ × 2½ ins., the vertical sides of which are riveted to the sides and floor, while the horizontal top is riveted to the cross timbers. The side and end planks are 1-in. thick, while the floor is of 2¼-in. tongued and grooved planks. A ridge is built over the sills to prevent the lodging of coal, etc., and this is plated with ⅛-in. steel.

The doors are of 1¾-in. plank, and give a clear hopper opening 3 ft. 4 ins. wide, extending across the car. Chains attached to the end of each door are attached to a chain passing over a grooved wheel fitted with a pawl and ratchet. The cars have M. C. B. couplers, malleable iron buffer blocks bolted directly to the faces of the end sills (which are fitted with angle-iron striking plates), grab irons, Westinghouse brakes, and hand brake gear, with a footboard on the end of the car for the man operating the hand brakes.

Trucks.

The trucks for these 100,000-lb. cars are shown in Fig. 3. They are of the diamond frame pattern, but the frames are of exceptionally heavy construction. The upper and lower arch bars, instead of being flat, are rolled channels 4½ ins. wide, with a 2½-in. groove ¾-in. deep, as shown on the drawings. The upper arch bars are ⅞ to 1⅝ ins. in thickness, and the lower arch bars ⅞ to 1½ ins. in thickness. The bottom tie bar is flat, ⅝ × 4½ ins. The bolsters are of basic open-hearth cast steel, of inverted trough section, with fish-bellied sides. The ends project through the frames and have grooves to fit the upper arch bars and the columns. A saddle resting on the lower arch bar forms the seat for a nest of four double helical springs, upon which rests the end of the bolster. The axles are 5½ ins. diameter at the middle, and have journals 5 × 9 ins. The brakes are placed inside the wheels, with the trussed steel brake-beams of the National Hollow Brakebeam Co. suspended from the bolster. Two flat diagonal bars or braces connect the frames transversely, the ends lying between the lower arch bars and tie-bars, and being secured by the column bolts. These braces are dished so as to stiffen them vertically.

The dimensions of these cars and of their principal members are given below in tabular form:

100,000-lb. Freight Cars; Southern Pacific Ry.

	Box car.	Coal car.
Length over end sills	40 ft. 0 ins.	36 ft. 0 ins.
Over running board	41 " 2 "	.....
Inside	39 " 5 "	33 ft. 11 ins.
Width over eaves	9 " 4¼"	.....
Over sills	8 " 9 "	9 ft. 0 ins.
Inside, clear	8 " 2½"	8 " 3 "
Height, rail to bottom of sill	3 " 3¼"	.....
Rail to eaves	11 " 9⅝"	.....
To top running board	12 " 5¾"	.....
To top of side	.....	10 ft. 5¾ ins.
To floor	4 ft. 2 ins.	.....
To bottom of hopper	.....	2 ft. 3 ins.
To c. line of coupler	2 ft. 10½ ins.	2 "10½"
Inside, clear	6 " 11¼ "	5 to 8 ft.
Doorways	5½ × 6⅔ ft.	.....
Side sills	(2) 4½×9 ins.	(2) 5 × 9 ins.
Intermediate sills	(2) 4 × 9 "	(2) 3½×9 "
Center sills	(2) 5 × 9 "	(2) 5 × 9 "
Sub sills	(2) 5 × 5 "	(2) 5 × 4½"
Draft timbers	8½ × 6 ins.	8½ × 6 ins.
End sills	6 ×10 "	6 ×10 "
Side posts	2½×3 ins. and 2½×3¾ ins.	3½ × 3¾ ins.
End posts	2½ × 4 ins.	3½ × 3¾ ins.
Corner posts	4 × 5 "	3½ × 3¾ "
Door posts	3⅜ × 5 "	.....
Side braces, thickness	2½ ins.	3½ ins.
Width	4 to 7¼ ins.	2¼ to 7 ins.
End braces	2½ × 4 ins.	3½ × 3¾ ins.
Side plates	3 × 6½ "	.....
Vertical rods	½-in. & ⅝-in.	⅝-in. & ¾-in.
Upset ends	⅝-in. & ¾-in.	¾-in. & ⅞-in.
Transoms	4½ × 7½ ins.	.....
Truss rods	(2) 1¼ ins. (4) 1⅛ "	(2) ⅞-in. (2) 1¼ ins.
Truss depth	1 ft. 7½ ins.	.....
Wheels, diameter	2 " 9 "	2 ft. 9 ins.
Journals	5 × 9 ins.	5 × 9 ins.
Wheel base, truck	5 ft.	5 ft.
Distance, c. to c. of trucks	30 "	26 "
Capacity, rated	100,000 lbs.	100,000 lbs.
Capacity, rated	2,328 cu. ft.	1,682 cu. ft.
Weight of body, empty	20,482 lbs.	19,952 lbs.
Of one truck	6,458 "	6,458 "
Of car complete	33,398 "	32,868 "
Floor area	323.88 sq. ft.	.....
Live load	75%	75%
Dead load	25%	25%

Car Service.

From Mr. J. Kruttschritt, Vice-President and General Manager of the Southern Pacific Ry., we have obtained some interesting particulars as to the cars and their service, from which it appears that they were built under direct orders from Mr. C. P. Huntington, as already noted. The approximate cost of the cars was $675 per car for the box cars and $650 for the coal cars, but prices of course vary with the market prices of materials. The box cars are built for general traffic, but are confined as far as possible to the overland freight routes between San Francisco and Ogden, and San Francisco and New Orleans. They actually go over all parts of the road, however, and at present, therefore, they are not loaded above 75,000 lbs., as they cannot be fully loaded until a number of structures have been renewed. The coal cars are confined to the traffic between the mines of the Rio Grande Western R. R. and the coaling stations on the Central Pacific Ry., and on lines in California where the structures can safely carry them with full loads. These cars, therefore, are regularly loaded with 100,000 to 105,000 lbs. of coal.

The box cars are very generally loaded to their present limit of 75,000 lbs., as the Southern Pacific Ry. devotes a great deal of time and attention to following up the loading of freight cars. Every station agent is required to fill out a form giving the following information for each car loaded under his supervision during the month: (1) the commodity, (2) the net weight and capacity, (3) the average weight per car, and (4) the percentage of capacity used, in space or weight. These reports are tabulated by divisions and sent to the manager's office, where the work of each agent is carefully examined, criticism being made on poor work and commendations on good work. Explanations are called for in every case of cars not being loaded to their full capacity. In October, 1899, the average load per loaded car was 16.6 tons on the Atlantic System, and 17.49 tons on the Pacific System. When these methods were first introduced station agents were promised that their efforts to secure better loading would be recognized, and after about six months use of the blank forms above noted, money premiums were paid to all those station agents who showed the best records. An examination of one of these reports from station agents shows that out of 16 cases of underloading, in only two cases was correspondence with the general manager's office necessary. In the other cases there were valid reasons for underloading, such as the load being the full amount of the shipment, or the car being the smallest available.

The full loading of cars is inspected as follows: The division superintendents at New Orleans, San Francisco, Los Angeles, Portland, and other points are instructed to report to the general manager's office on a special blank form all cases of underloaded cars reaching their stations. By prescribing these rules for some 15 to 20 of the largest stations, fully 90 to 95% of the traffic over the company's lines is checked. In every case where a car is reported as not loaded to either space or weight capacity, explanations are required. At the foot of the heavy mountain grades a close inspection is made of the loading of cars, and wherever the freight is such that it can be transferred without injury, the loads are consolidated in order to reduce to a minimum the number of cars to be hauled. In the busiest months the unnecessary haul of partly loaded cars over these heavy grades and over long stretches beyond is saved on from 500 to 700 cars per month.

In regard to the policy of checking the loading of cars, the following table shows the increase of carrying capacity and increase of load carried for several years on both systems of the Southern Pacific Ry. This shows that on the Atlantic System the increase in carrying capacity was 46%, while the increase in load carried per car was 72%. On the Pacific System, the increase in carrying capacity was 25%, while that of the load carried was 50%.

Freight Car Capacity and Loads; Southern Pacific Ry.

	Systems—Atlantic—		—Pacific—	
Date.	Average capacity of freight cars owned, tons.	Tons of freight per loaded car, tons.	Average capacity of freight cars owned, tons.	Tons of freight per loaded car, tons.
1887	16.32	9.90	.....	.....
1888	17.75	10.38	.....	.....
1889	17.76	10.46	18.84	10.62
1890	18.05	11.04	19.20	11.70
1891	19.86	11.67	19.56	12.11
1892	20.60	12.07	20.03	11.98
1893	21.26	13.10	20.36	12.75
1894	21.26	13.75	20.65	13.58
1895	21.76	14.08	21.35	13.52
1896	21.76	14.73	21.54	14.21
1897	21.76	15.02	21.64	14.53
1898	22.33	15.75	22.10	15.04
1899	23.81	17.03	23.63	15.96
Inc.	46%	72%	25%	50%

BOOK REVIEWS.

WATER AND WATER SUPPLIES.—By John C. Thresh, D. Sc., M. D., Medical Officer of Health to the Essex County Council, etc., etc. Second revised edition. Philadelphia: P. Blakiston & Co. Cloth; 5 × 8 ins.; pp. 438; tables and illustrations. $2.

Although written from the point of view of an English county health officer this is a very good elementary presentation of most of the facts relating to the character of public water supplies and the general methods of their development. The author has made good use of the reports of the Massachusetts State Board of Health and some other sources of information, but the authorities cited, both English and otherwise, are rarely later than 1892. The different sources of water supply are reviewed with care, and numerous analyses of various classes of water are presented. Reservoirs, pumps, and distribution systems are taken up, but most of the space is devoted to the quality of water. There is a chapter on "The Law Relating to Water Supplies," and a table of water rates charged in English municipalities. A foot-note to p. 281 contains the statement: "A meter suitable for small consumers is a want yet to be supplied," showing that the author consulted American authorities on the quality of water more thoroughly than those treating of details of distribution and management. The book is well worth its price as showing how many water problems are solved in England, and how the various questions involved are regarded by an intelligent county health officer. The latter point suggests the thought that many of our States might well provide for like officers, particularly for counties made up of small villages and towns, which do not realize the need of employing competent health officers, or think they cannot afford it, but which might do so by joint action. So far as we know, Connecticut is the only one of our States having county health officers.

THE NEW YORK AIR BRAKE CO. is reported as having a large contract for air brake equipment for railways in Russia, one condition of the contract being that a factory must be established in Russia within two years. Some shipments have already been made.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

We desire to call the attention of those interested in the electrolysis of gas, water and other pipes to the admirable article on that subject by Mr. Dabney H. Maury, Jr., printed elsewhere in this issue. The article brings out clearly the most salient points of this subject, and recounts some highly interesting experiments made by Mr. Maury and others working with him. It emphasizes the fact that the responsibility for electrolysis lies with the street railway companies, and that they should be called upon to remedy the trouble, instead of relying upon the owners of gas and water mains to protect their property as best they may, or let it go to ruin unhindered. Mr. Maury does not hesitate to say that the way to stop electrolysis is for the street railways to adopt the double trolley system, thus returning the current through their own wires, instead of through the gas and water mains belonging to other companies or to municipalities. The same sentiment as to who should bear this burden was forcibly expressed at the recent meeting of the Western Gas Association by Mr. Donald McDonald, of Louisville, Ky., in the following words:

> As to the suggestion that if the pipes are put 1 ft. apart the danger from electrolysis is increased, I will say I look forward to the time when gas men will no longer sit idly by and see their structures destroyed by electrolysis. Why on earth millions of capital, put legally and honestly into the earth, should be allowed to be destroyed to save another concern the task of putting one wire more in their system, I do not see; and I do not think we ought to be compelled to construct our underground system of pipes with a view to so placing them that electricity cannot destroy them. The action of the electric companies in that matter seems to be almost wanton.

The Chinese artillery has been a source of great surprise to the allied troops who have recently been in conflict with Chinese troops at Pekin, Tien-Tsin, the Taku forts and in the unsuccessful advance upon Pekin. In China, as in South Africa, the number, size and power of the guns brought to oppose the invaders have been far beyond all expectations on the part of the latter, and the disasters which have occurred in both cases are largely attributable to this cause. The lack of information on the part of the British authorities as to the artillery power of the two South African republics appears to have been due in great measure to the neglect and inefficiency of the intelligence department of the War Office, as subsequent investigation has shown that large quantities of guns and ammunition had been purchased within recent years from such great European firms as those of Krupp and Creusot. In China, the same holds good to some extent, but it must be remembered that the Chinese government has extensive arsenals of its own, which have for years been operated by European officials. Our English contemporary, "The Engineer," has recently republished an article written in 1898 by a correspondent who visited the Kiang-Nan arsenal, near Shanghai, which was started some 30 years ago and has been under foreign management from the first, employing about 2,500 men. These works are equipped for making small arms, rapid-firing guns of small caliber, and guns up to 12 ins. bore. Since 1890 a number of 50-ton guns have been built. The article in question stated that all the material turned out, whether rifles, machine guns, heavy ordnance or complicated self-acting gun carriages, had the appearance of being of excellent quality. In regard to the output we quote the following paragraph:

> I am not at liberty to say very much about the types of guns, and so on, but it is as well to mention that in the heavier classes the Armstrong pattern is almost universally adopted. Annually, and for many years past, large quantities of war material have been turned out here. And what becomes of it? Nobody knows. It absorbs itself somehow, I am told, without the defences of China appearing to be strengthened by the process. But China is a large country; large enough, in fact, to employ a very great supply of war material in districts away from the beaten track of the foreigner in China. And can the Chinaman use these guns to his own advantage or for the protection of his country when he has made them, or does he wish to do so if he could? These are questions which one would imagine to be all important. But, at the same time, I cannot answer any one of them.

The campaign against water pollution is meeting with temporary defeat in a number of States. As we have already noted, the Court of Errors and Appeals of New Jersey has reversed the Paterson and Newark decisions enjoining further pollution of the Passaic, and an Indiana court has rendered an apparently ridiculous decision permitting pollution there. None of the three cases just cited involved streams now used for public water supply. It has been left to Pennsylvania, a State extremely backward in public sanitation, to have its State Supreme Court uphold the discharge of sewage wastes into a public water supply. In our issue of Aug. 3, 1899, we reviewed editorially a decision of the Superior Court to the effect that the discharge of sewage from a house into a stream tributary to the water supply of York, Pa., as furnished by the York Water Co., was a public nuisance. The Supreme Court declares that the alleged offender Dr. (!!) Geo. P. Yost, should have been acquitted, as ordered by the Court of Quarter Sessions. The main points of the decision, as given by the Philadelphia "Public Ledger," of July 12, were as follows:

> If the public, having a right to take from this stream pure and unpolluted water, found in it the germs of disease coming from the cesspool of the defendant, which he maintained on a tributary of the stream, his offence would be a public one, for which he would be properly indicted. The wrong would be against the whole community as a community, not simply against an individual or certain individuals, however numerous, and ought to be punished as a crime. If the public have a right to receive pure water through the agency of a corporation legally authorized to take it from a stream, he who pollutes it offends against the public.
>
> * * * * * * * *
>
> The rights of the York Water Co. were, under the evidence produced, simply those of an ordinary riparian owner, having no ownership in the running water and no right to divert or sell the same for general use, whether pure or impure. As an individual, it could complain of the alleged pollution of the water and it alone, for which it was a civil remedy. Before the defendant could be convicted of any offence against the public, it was the duty of the commonwealth to show that he had offended against the rights of the public. No such offence was proven. The right of the public to use the water pumped by the York Water Co. was shown. Any wrong committed was a private one, for which the remedy was purely civil.

There may be a ray of hope in the last of these two paragraphs if the language means that the company had no legal right to divert the water in question, but we fear that is not the intent of Judge Brown. Certainly something is wrong with the Legislature and courts of Pennsylvania if a private company is allowed to supply a community with water and lacks means for the most speedy action in the protection of the quality of the supply.

THE COMPARATIVE COST OF RAIL AND WATER TRANSPORTATION IN EUROPE.

The development of river and canal transportation systems in Europe, especially in France and Germany, has long been a stock argument with those who favor large expenditures in this country on similar works. In the recent report of Governor Roosevelt's Advisory Committee on the policy of the State of New York toward its canals, much space was devoted to the work which has been done abroad in reviving water transportation systems, and it was argued that since France and Germany have adopted this policy it must also be a good one for the United States to follow.

In all the literature on the European canals which has been spread abroad in this country, however, we have yet to find a single statement of the average actual cost of transportation on any of them. The canal advocates have contented themselves with vague generalities, and we have never anywhere seen presented any detailed statement either of the actual cost of inland water transportation abroad or of the relation of that cost to the cost of similar service by European railways.

Recently, however, through the courtesy of Mr. E. L. Corthell, M. Am. Soc. C. E., we have obtained copies of two important treatises written by European engineers of high standing on the general subject of transportation, and we have translated that part of these treatises which bears most directly upon the subject above stated.

The first of these works is entitled "Transports et Tarifs," by C. Colson, Chief Engineer of the Ponts et Chaussees, State Councillor, and formerly Director of Railways in the Department of Public Works. It is a bulky octavo of nearly 700 pages, and was published at Paris in 1898, by J. Rothschild, 13 Rue des Saints-Peres. French practice is chiefly referred to in the work, although the experience of other countries is more or less touched upon. Necessarily our translation can be only a review of the author's general position so far as it bears upon the question at issue.

At the outset Mr. Colson tells us that there is in France constant and active competition between railways and water transport lines, although the competition of the canals is chiefly confined to slow freight. In England the competition between the railways and canals led to the absorption or control of the latter by the former. In France the same thing has not happened simply because the government owned the canals, paid for their maintenance, and made it impossible for the competing railways to bankrupt and absorb them as they would otherwise have done.

It is very generally asserted, says Mr. Colson, that water navigation is the most economical method of transport, and that railway carriage is more expensive; but this current opinion he believes to be exactly contrary to the truth. The difference in the cost of the two systems is neither constant nor considerable; but in most cases he finds it to be clearly in favor of the railway. If the reverse appears to be the case, it will be found to be because the shipper pays the cost of maintenance and capital charges in sending his goods by rail, whereas these charges are assumed by the State if he sends his goods by canal or river.

In another part of his work Mr. Colson shows that in transport by water the average net cost

as reported represented little more than the freight paid to the boatmen. With free competition the boatmen could not maintain their rates above the sum necessary to cover their expenses, including in this the interest on their little capital and their own remuneration. The cost of maintenance and administration of the canal, and the interest on the capital invested, under the French systems, are not included at all in estimating the cost of water transportation. Thus the actual cost of water transport is largely understated in the published and official reports.

With a sufficient approximation, says Mr. Colson, the net cost of moving freight by water may be measured by the freight paid on the best rates—which is about 1 centime per kilometric ton (say 0.32 cts. per ton-mile), though the rate is much more frequently over than under this figure. In calculating the annual expenses of a "peniche," or an ordinary canal boat, he finds that this cost amounts to about 1.5 francs per kilometer run, or nearly 50 cts. per mile. Assuming that the load is 300 to 350 metric tons in one direction, and that the return trip is made without a load three times out of four, the cost of the boat expenses alone amount to about 1 centime per kilometric ton, as before stated.

Upon railways, the average expenses of operation amount to 2.27 francs per train-kilometer, according to the statistics of 1896, and the mean train load of merchandise is 94 tons; this would appear to represent a net cost of 2.42 centimes per kilometric ton, or more than double the cost of water transport. But the complexity of the railway service will not warrant so summary a conclusion. In the first place, the 2.27 francs for the railway represent several other elements besides those corresponding to the money paid to the boatmen. In this figure the general expenses of administration amount to 0.25 francs; and those for maintenance of way to 0.41 francs. In the case of the canals these expenses are paid by the State and do not enter into the charge for freight. The railway rate also includes 0.76 francs for the staff at stations and that employed in handling goods, as well as that employed in the maintenance of way. The boatman does not pay these charges, for all goods are handled at the cost of the sender or receiver. If these expenses are added to the 1 centime per kilometric ton mentioned as the charge for water transportation, it will be found that the actual expense of rail and water transportation is approximately the same.

The above comparison is made on the basis of average returns for the whole country, but a more useful comparison may be made between railways of easy grades and heavy traffic and the canals directly competing with them. The net freight train load on such railways reaches 300 to 500 tons. While the return of empty cars must be considered, the proportion of empty cars is a little less than that of empty boats, as the railway is better able to obtain return freight. In Paris, for example, the proportions of loads sent out to those arriving is 21 per 100 for boats and 39 per 100 on the railways. Even if we admit that the empty cars reduce the mean load of the round trip to 250 or 300 tons, in competition with canals, it is evident that this is considerably larger than the mean load of the canal boats for the same round trip, as the latter average rarely exceeds 200 tons. By dividing the sum of 1.5 to 2 francs by the average load of the train under the above conditions, we obtain a net cost of 0.6 to 0.8 centimes per kilometric ton, or very considerably less than the cost of traffic by canals.

It is true that on wide and deep rivers like the Seine, where boats of large dimensions can be towed by steam power, the net cost per kilometer-ton is very greatly reduced. But these conditions are not met with on the average river, with a more or less rapid current and sinuous course, both adding to the cost.

In another part of his work Mr. Colson discusses the comparative first cost of construction of railways and canals. He reaches the conclusion that on the average the cost of a canal suitable for heavy traffic and that of a first-class double-track railway line with easy grades will each amount to 400,000 to 500,000 francs per kilometer (say $120,000 to $160,000 per mile). The railway still has an advantage over the canal, however, in that it serves for the transport of passengers and high-class merchandise as well as for bulk freights.

Taking up the question of the relative capacity of the two systems, he urges that here again the railway is superior to the canal. The canal of Saint Quentin, for example, reaches its limit of capacity with a traffic of 100 boats per day; to send more boats through would require the doubling of the locks. A double track railway, on the other hand, can move 100 trains a day each way without difficulty. If it is desired to increase the capacity of a railway, it may be done almost indefinitely by building an additional track on certain sections. Under any but very exceptional circumstances the work to be done to enable a railway to respond to all requirements costs far less than it would to create a navigable waterway capable of meeting similar demands.

Again, in considering the requirements of traffic a water route never satisfies the demand of a district for transportation facilities. If a canal were undertaken as a private enterprise, the investors may at any time expect the construction of a competing railway. A canal can only perform part of the public transportation service which modern necessities demand, while a railway line meets all requirements, and would render a competing canal unprofitable if it did not actually prevent its construction.

It may be urged, however, that the above argument only applies to artificial waterways and that where natural waterways can be utilized there is nothing to offset the first cost of construction of the railway. Mr. Colson points out, however, that on almost all natural waterways great sums are expended by the State to fit them for navigation. For example, France has expended during the past 40 years upon the Rhone an average of 250,000 francs per kilometer of navigable course and double this amount per kilometer on the Seine.

Taking up the matter of the handling of goods at terminals, he points out that under the conditions existing in France the waterways have some advantage in this particular. French warehouses and factories are very generally located alongside waterways so that the merchandise is received and delivered directly from the boats. With the railways, cartage to and from the station is necessary unless a spur track runs directly to the shipper's warehouse or factory, and this condition is far less common in France than in the United States. Inasmuch as the terminal charge is the same for short as for long shipments, Mr. Colson points out that in France the canals compete with the railways most successfully on short distance traffic. On long hauls the railway's advantage in cheaper carriage enables it to underbid the canal.

The next point considered by the author is that not only comparative cost, but comparative character of service rendered must be considered in contrasting the two systems. At an equal cost the railway carries goods at greater speed, and with greater regularity and reliability. Water routes are notoriously subject to interference by accidents, ice, delays, etc. Thus the merchant or manufacturer who relies on water transport must carry larger stocks and keep greater capital idle in them than the one who ships by rail.

Practical experience shows that shippers prefer the railway to the canal, even at a higher freight rate. Often the rate by rail will be 20% higher than that by canal; yet the shipper will choose it in preference.

In another part of his work Mr. Colson reviews the competition between railways and canals which has gone on in England. He points out how the railways, possessing a traffic in passengers and high class merchandise which the canals could not touch, were able to survive in the competitive struggle. The warfare frequently closed by the railway company acquiring control of the canal; and of the 4,154 miles of canals in the United Kingdom, the railways now own 1,240 miles, comprising the best part of the waterways.

In France a similar absorption of the canals by the railway companies has been prevented only by the ownership of the canals by the State. Thus the taxpayers have met the interest on invested capital and the cost of maintenance and operation, and traffic has been retained by reducing or abolishing toll charges. Even under this condition the railways could underbid for much of the traffic which the canals carry and would do so except that this would necessitate lowering their rates on a large part of their own traffic.

For example, in 1896, of the coal brought to Paris, 1,195,000 tons came by water and 1,745,000 by rail. The canals, over a distance of 340 to 380 kilometers, charged 4 to 6 francs per ton in ordinary times, or 1.2 to 1.5 centimes per ton-kilometer; and the trip was made in 20 days. The Northern Ry. charged about 7 francs for a route of 220 to 240 kilometers, or about 3 centimes per kilometer, with a maximum of 14 days in transit. Mr. Colson says that the railway could doubtless have carried this coal for 4½ to 5 francs per ton, and then have made 50 centimes to 1 franc profit per ton, and had it done this, would certainly have taken from the canals a large part of their traffic. But the railway company would have been obliged to apply this reduced rate to all its traffic, and its profit on the coal taken from the canals would have been offset several times over by its losses on other business.

The other work to which we referred at the outset of this article is "Kanals A, B, C, by Fritz Geck, Engineer, published by "Kanalvereines fur Niedersachsur Zu Hannover," in 1899. It is an entirely different sort of work from the one reviewed above, being chiefly devoted to tables and statistics bearing on the questions at issue, from which data the reader is expected to dig out his own conclusions in true German fashion.

In Germany, as our readers will remember, both railways and canals are owned and maintained by the State and there is no such thing as the free play of competitive forces. The freight on the railways and the tolls on the canals are fixed by State officials and are not varied to meet exigencies of competition as is done in the United States. An inspection of these tariffs shows that the rates on canal shipments in all the cases given are invariably considerably less than those on the same class of goods sent by rail. On the other hand German railways pay a large profit into the national treasury, while the canals and waterways are aided every year by large outlays from the same source. Thus the shipper of goods by rail helps pay the nation's taxes, while the shipper by water has part of the cost of transport borne by the taxpayers.

If definite figures are desired, it may be noted that in 1897 Prussian State railways showed the following results:

Income	1,197,521,603	marks.
Expenses	722,648,907	"
Net income	474,872,696	"

German waterways, on the other hand, require for their operation and maintenance an average annual expenditure of about 2,150 marks per kilometer. Of this amount, about 750 marks comes from the tolls collected on them and 1,400 marks from the State treasury.

The average operating expenses per ton-kilometer on the Prussian State Railways in 1894 was 2.29 pfennigs (1 ct. per ton mile). The average earnings per ton-kilometer were 3.84 pfennigs (1.25 cts. per ton-mile).

The lowest rail and water rate noted are on export goods and are respectively 1.3 pfennigs per ton-kilometer by rail and 0.8 pfennig per ton-kilometer by canal. These are equivalent to 5.72 mills per ton-mile and 3.52 mills per ton-mile respectively.

It will be seen from the above figures that the Prussian railway freight rates are far above the rates charged on American railways; and in this is to be found the explanation of the growth in traffic on German waterways.

The most important point to be noted, however, is that the freight rates on German waterways are actually higher than the rates charged on American railways of heavy traffic, and this notwithstanding the fact that the waterway rate includes only one-third of the cost of operating and maintaining the waterway, the remainder of this cost being borne by the taxpayers.

We submit the above facts and figures without further comment to the consideration of those interested in the current discussion on the compara-

tive economy of rail and canal transportation under modern conditions. We are well aware and have frequently pointed out that the conditions here and abroad are so dissimilar that practice there cannot be taken as a safe guide in shaping the policy of this country. The argument that the United States should follow the example of France and Germany in the development of waterways has been so frequently brought forward, however, that it has seemed proper to set forth the actual facts regarding foreign transportation systems as they are presented by foreign engineers so that our readers can form their own conclusions.

LETTERS TO THE EDITOR.

The Street Railway Accident at Tacoma, Wash.

Sir: A very serious accident, causing the death of 49 passengers and more or less serious injury to 53 more, occurred on the morning of July 4 on the "Edison" line of the Tacoma Railway & Motor Co. A large double-truck car of the above line loaded with excursionists got beyond control of the motorman while descending the steep hill beside Gallagher's Gulch, having a grade averaging nearly 10%, and, after running nearly half a mile, jumped the track at the curve leading on to the bridge crossing the gulch at C and 26th Sts. It ran to the edge of the roadbed, and, striking the guard rail, turned over and fell about 40 ft. down the side of the gulch, striking upon its roof, the motors and trucks crashing through the floor and literally smashing the woodwork into kindling.

VIEW OF THE WRECK ON THE ELECTRIC LINE OF THE TACOMA RY. & MOTOR CO., TACOMA, WASH.

The coroner's jury have not yet concluded their investigations, and, pending their verdict, the whole truth cannot be learned.

The causes leading up to this accident are various, covering the operation, rolling stock and roadbed. In operation there have been a great many changes in the conductors and motormen in the past two months, amounting to an almost entire change of staff. The motorman of the car (who has died of his injuries since the accident) had been in the company's employ for less than a month; and, it is reported, had never taken a car over this line before the day of the accident. The conductor (who died while being taken to the hospital), while an older employee, was not accustomed to running with the motorman and so they did not act in concert.

The car was very seriously overloaded (there are no laws, either State or city, on this point), there having been about 125 men, women and children aboard. As the normal seating capacity was but 40 and the car was designed for a live load of about 5 tons only, this excessive load caused the car to "pound" and settled it down so far on the trucks that the brakeshoes failed to take a proper grip on the wheels and all the machinery was more or less displaced. Moreover, the excess number of 60 to 70 persons were hanging on the straps and bars in the roof of the car and swinging pendulum-like, as the car ran around the frequent curves. This weight of four tons and more hanging so high above the center of gravity undoubtedly influenced the final result.

The car was not structurally strong, as the rear platform broke down under the weight of those attempting to get out just before the fatal curve was reached. It had "pony" or "maximum traction" trucks (one pair of large and one pair of small wheels on each truck), which are apt to cause cars to "jump" on poor track, and had no braking appliances save the primitive hand brakes.

The track is made of 45-lb. steel "steam" rail laid on 6 × 8-in. ties, 18 to the rail length, and is well ballasted, as the soil is chiefly gravel. The approach to the bridge is on a curve of 125 ft. radius with a guard rail beside the inside rail, but without any rerailing device. On the lower (or outside of the curve) side of the bridge is a 12 × 12-in. timber with a 45-lb. rail spiked on top of it, bolted to the bridge timbers parallel to and about 10 ft. distant from the track crossing the bridge. All value of this as a protection is lost, however, because of the fact that the grade of the track has been super-elevated above that of the bridge so that at the end of the bridge the top of rail is nearly a foot above this timber guard.

That there was something radically wrong at this point was shown by a similar accident a year ago when a "wood train" attached to a dummy ran down the hill and jumped off the bridge within 10 ft. of the same spot. The roadbed was repaired at that time, but the end of a cap and the batter post in a trestle bent were never repaired nor replaced.

A. McL. Hawks.

Tacoma, Wash.

Cross-Sectioning for Computing Earth-Work.

Sir: In the accompanying diagram C D E I represents half a cross-section, having a form that occurs frequently in railway work, in connection with the calculation of cuts and fills; C is the center stake, whose elevation above the subgrade D E is denoted by h; E F is the side slope, and C I is the surface of the ground, whose inclination is assumed to be practically uniform (a very common condition). Width of subgrade = 2 D E = 2 w; angle of side slope = α; cot α = r.

The transitman or leveler in charge of staking out the line has to determine, besides the center cut (or fill, as the case may be), the "distance out" C H (= d, say), and the elevation h^1 of I above sub-grade. The determination of the two latter quantities, and therefore of the point I, where a stake should be driven, is a source of much trouble to the beginner. The cause of the trouble lies in the approximate and trial methods commonly employed and taught, in which no hint is given as to the degree of approximation attained, nor, therefore, as to the correction to be applied to an assumed value in order to obtain a closer one.

In his most valuable work on surveying, Prof. J. B. Johnson says: "If the ground were level transversely, the distance to the slope stakes would be

$$d = h\,r + w.$$

But this is not usually the case, and hence the distance out must be found by trial."

This trial method is founded on the following equation (see Fig.):

$$d = C\,H = D\,G = w + h^1 \cot \alpha;$$

that is,

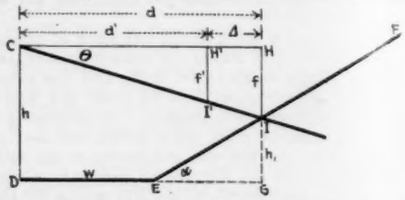
$$d = w + r\,h^1. \qquad (1)$$

The rodman (or the leveler) estimates by eye where the distance out should be; this distance (which we shall call d_1) is measured, the rod is read on the point thus determined, and the elevation h_1 of this point above grade is computed. Then, if the distance assumed is the correct one, we must have [equation (1)]

$$d_1 = w + r\,h_1.$$

If this equation is not satisfied by the values of d_1 and h_1 determined as explained (and these values seldom satisfy the equation), a new value must be assumed for d_1, and the operations repeated.

Prof. Johnson further says that "the whole operation is a very simple one in practice," and that "the rodman soon becomes very expert in estimating nearly the proper position the first time." How soon one can become expert in this kind of unsystematic guesswork I do not know; but I do know that the beginner seldom fails to make ridiculously inaccurate guesses in thus estimating quantities at random, without any hint that he may be guided by. The result is that he has to try three or four distances, and work out the formula three or four times, and this, of course, causes a great waste of time, to say nothing of the worry of the poor novice.



Of course, it will occur to anyone that the surest and most rational way to proceed is to determine first the inclination of the sloping ground (angle θ in the figure). This done, an exact (or very nearly exact) formula can be written for d, and one for h^1. Such a method is given in some books, as in Searles'. The resulting formulas, as usually given, however, are comparatively cumbersome. They can, however, be much simplified and reduced to very convenient forms in the following manner:

If the difference $h - h^1$ (to be determined) is denoted by f, equation (1) may be written,

$$d = w + r\,(h - f) = w + r\,(h - d \tan \theta);$$

whence

$$d = \frac{w + r\,h}{1 + r \tan \theta}.$$

Measure out any distance C H^1 (= d^1, say), and determine the fall f^1 of I^1 below C. Then, $\tan \theta = f^1 \div d^1$, and the preceding equation becomes

$$d = \frac{w + r\,h}{1 + r\,\dfrac{f^1}{d^1}}.$$

If, for convenience, we make $d^1 = 2\,w$ (it is not advisable to make d^1 too small), we obtain

$$d = \frac{w + r\,h}{1 + r\,\dfrac{f^1}{2\,w}};$$

and, if we denote the distance H^1 H to be added to d^1, or 2 w, in order to get d, by Δ, we shall have,

$$\Delta = d - 2\,w = \frac{h - f - \dfrac{w}{r}}{\dfrac{1}{r} + \dfrac{1}{2\,w}\,f^1};$$

or, writing r^1 for $\dfrac{1}{r}$, c for $\dfrac{1}{2\,w}$, and c^1 for $\dfrac{w}{r}$,

$$\Delta = \frac{h - (f^1 + c^1)}{r^1 + c\,f^1}. \qquad (2)$$

The constants c, c^1 and r^1 may be calculated before beginning the field work, and the formula written in some convenient place in the note book. Thus, if w = 10 ft., and $r = \dfrac{3}{2}$, we have

$$r^1 = \frac{2}{3} = .67,\quad c^1 = \frac{10}{3+2} = 6.67,\quad c = \frac{1}{20} = .05,$$

and the formula will stand like this:

$$\Delta = \frac{h - (f^1 + 6.67)}{.67 + .05\,f^1}.$$

The arithmetical operations to be performed are very simple, so much the more so as they have not to be performed with rigorous exactness. Besides, the formula has the advantage of giving the required distance at once. The elevation h^1 is obtained from equation (1):

$$\frac{d-w}{r} = \frac{(2w+\triangle)-w}{r} = (w+\triangle)\,r^1. \qquad (3)$$

The drill $f\ (= h - h^1)$ should be checked by reading the rod using the computed distance d.

If h^1 is an angle of elevation, f^1 will be the elevation of I^1 above C, and the only change necessary is to write $-f^1$ instead of f^1 in formula (2). If, instead of a cut, we have a fill, formula (2) applies for an angle of elevation, f^1 being the elevation of I^1 above C; for an angle of depression, f^1 is the fall of I^1 below C, and its sign should be changed in formula (2). Formulas (1) and (3) are perfectly general. As to formula (3), the following is a convenient working rule: If $h - h^1$ is positive, apply the formula as it stands; if negative, change the sign of f^1.

Antonio Llano.

International Correspondence Schools, Scranton, Pa., June 5, 1900.

GARBAGE REDUCTION AT COLUMBUS, O.

The garbage of Columbus, O., is collected, removed from the city and treated in reduction works under a contract awarded on Dec. 10, 1895, to Messrs. Geo. and Chas. Geigele, of Columbus. The contract runs for ten years from April, 1896, the price being $15,800 a year, including the removal and disposal of dead animals. Garbage from hotels and retail stores is included in the contract, but not that from wholesale fruit and vegetable stores. The contract contains no provision relating to final disposal, except that it shall be by the reduction process. A city ordinance makes it unlawful, under a penalty of $5 to $50, to deposit ashes or any other matter except "garbage and offal" in the garbage cans, and defines those two words as follows:

The words "garbage and offal" as used in this ordinance shall be held to include every refuse accumulation of animal, fruit or vegetable matter, liquid or otherwise, that attends the preparation, use, cooking, dealing in, or storage of meats, fish, fowls, fruits or vegetables. And it shall be unlawful for any person to place in said vessels or tanks any ashes, refuse, waste or other material whatsoever.

Shortly after the award of the contract the Columbus Sanitary Co. was organized, the officers of which are now as follows: President, Geo. Geigele; Secretary, Fred. C. Janton; Superintendent, John C. Curry. The company bought its original equipment outright from the Detroit Sanitary Co., of Detroit, Mich., and opened the plant in April, 1896.

The garbage is collected by means of wagons having removable steel bodies, or tanks, capable of holding from one to two tons, according to the character of the material. From 14 to 16 wagons are in use in winter, and 21 to 26 in summer, extra boxes being provided for shipment to the works, as noted below. The collections vary with the season, from once to twice a week in the outlying districts, and from twice a week to daily service in the city, the daily service being quite limited.

The wagon boxes, or tanks, are taken to a shipping station on West Mound St., well within the city, hoisted onto special platform cars holding from 15 to 18 tanks, and then sent by rail to the reduction plant, located on Alum Creek, five miles southeast of the center of the city. Here the tanks are lifted from the cars by a 3-HP. automatic-balanced valve engine, speeded to about 500 revs. per min., and a duplex block, hung on an overhead track, so the engine can be moved the whole length of the car. The lift is 9 ft. The cars run from the hoist into the works on an inclined trolley, and the empties are run back by hand. Three men can unload 17 boxes in 40 minutes.

The tanks are dumped on a water-tight floor about 20 ft. sq., located between the tops of the two rows of digesters. Although the ordinance prohibits the mixing of tin cans and other foreign matter with the garbage, such large quantities are found that it is necessary to sort them out on this floor. The garbage is shoveled into the digesters, of which there are now six in use, two having been installed about the first of this year. One of the digesters has a capacity of five tons and the other five hold seven tons each, making 40 tons in all. The covers of the digesters are raised and lowered by a lift suspended from an overhead trolley. The original four digesters were made from ½-in. steel plates, which experience has shown are too thin. Each digester has a false bottom and sides, both perforated, on and in which the garbage is placed. The garbage is cooked under about 80 lbs. pressure, steam being admitted from the bottom for 5 to 8 hours, then reversed for from 1 to 5 hours, to remove as much grease and water as is possible. The whole process of filling, cooking, pressing and emptying averages ten hours, and the best work now possible is the reduction of three tank charges, or say 20 tons, in 24 hours.

Each digester tank is connected with an Anderson condenser and deodorizer, by means of an 8-in. cylinder tapped into the top of the tank, from which a 2-in. pipe leads to the condenser.

Until March, 1900, the tankage, after the draining and steam pressing already described, was dumped in a pile outside the works. This pile had reached large proportions in May, 1899, being, perhaps, 100 × 200 ft. in area and 10 ft. deep. It contained many tin cans, but did not seem to give off bad odors. About a year later, or soon after dumping on the pile was stopped, it was estimated that the pile contained 4,000 to 5,000 tons of tankage, practically none having been taken away. It did not appear to be offensive. In March, 1900, an Anderson improved drier was installed. It appears that it is similar to the driers of the same type used at Cleveland, O., and described and illustrated in our issue of May 31, 1900. The drier has a capacity of about two tons of dry stuff in 24 hours. Before going to the drier the tankage has to be picked over to remove rags and hard refuse, in order to prevent setting itself on fire, which it did shortly after it was put in use. The refuse sorted from both the tankage and the green garbage on the dumping floor is thrown onto the bank of Alum Creek.

The grease and water from the digesters passes to and through three other tanks, where it is heated and freed of some of its sediment; then it goes to a series of wooden boxes provided with baffle boards, where the grease is skimmed off. There are (or were in May, 1899) four horizontal, wooden tanks, each 6 × 16 ft. in plan and 3 ft. 10 ins. deep. The liquid travels the length of each box twice before the grease is skimmed off. The grease is then washed with hot water before barreling. The grease separating tanks are partly out of doors. The grease is a thick, brownish oil, free from grit. In November, 1899, Mr. Geigele stated that the grease from the plant had been sold recently to a Cincinnati firm at 3¾ cts. per lb., f. o. b. in Cincinnati, with no deductions for commission. In past years the price obtained for the grease had been as low as 2 cts. per lb. In April, 1900, Mr. Curry said the grease was worth $8 to $9 a barrel.

The water from the separating tanks, and also from the condensers, passes to a small settling basin, and thence to Alum Creek.

The waste water from the separating tanks goes directly to the creek, without treatment. During the first year of operation a filter bed was used to clarify this water. It clogged badly, and subsequently there was less complaint regarding the wastes from the works. The water contains less sediment than formerly.

Among improvements contemplated by the company are a tank car for service between the city and the plant, the car to be unloaded by a conveyor running directly to the digesters, thus avoiding the present objectionable dumping floor; also a conveyor to handle the dried tankage.

The force at the plant in May, 1899, consisted of a superintendent, two day and two night men in winter, and double the number of helpers in the summer; or five men in winter and nine in summer. This force does all the repair work. Besides the small engine for running the hoist for lifting the garbage boxes from the car, there is a 5-HP. engine to run an elevator.

The quantity of material treated at the plant in 1897 and 1899 (1898 not available) is given in the accompanying table, the tonnage being based on an assumed average weight of 1½ tons to each wagon tank removed from the city. The city, it will be remembered, pays $15,800 a year for the collection and disposal of garbage and dead animals, or quite a bit under $2 per ton, including a fair estimate for the weight of the animals.

Quantity of Material Treated at the Columbus Garbage Reduction Works in 1897 and 1899.

1897.	Tons.	Horses.	Cows.	Hogs.	Dogs.	Cats.
January	552	66	5	..	116	48
February	576	49	1	..	34	63
March	590	45	3	..	181	52
April	605	43	5	..	170	95
May	606	40	21	..	166	40
June	651	25	15	..	190	40
July	709	49	6	..	155	45
August	1,001	56	10	86	140	50
September	1,077	46	3	..	100	29
October	656	55	5	4	110	23
November	576	53	3	..	80	15
December	552	47	4	17	82	6
Total	8,158	574	81	107	1,524	506
1899.						
January	534	36	3	1	82	9
February	454	53	4	26	72	10
March	485	24	3	2	61	8
April	429	20	4	1	136	23
May	525	40	5	1	102	21
June	588	32	5	0	112	44
July	796	45	6	0	172	33
August	1,137	54	0	0	222	45
September	898	79	6	0	186	35
October	696	74	2	1	156	34
November	600	50	1	1	151	13
December	648	60	6	6	108	9
Total	7,790	673	45	39	1,560	284

In addition, there were treated in 1897, 1 camel, 1 monkey, 1 hippopotamus; and in 1899, 6 mules, 2 sheep, 12 rabbits, 1 goat, 1 seal and 1 deer.

Ever since the plant was put in operation there has been more or less complaint against it on the part of farmers living in the vicinity. In March, 1897, the court ordered the plant closed unless the cause for complaint was removed in some 60 days, this being the second time the matter had been in court. In October and November, 1897, the matter again came up on alleged contempt of court, because, the plaintiffs claimed, the plant was still being operated without the nuisances having been abated. The case seems to have been before the Court of Common Pleas in one form or another most of the time for the past three years, and has been in the Circuit Court, on appeal, once or twice. There have been nine suits against the company, including proceedings for alleged contempt of court for disobeying orders to make improvements or close down. There are now two such contempt cases in court. Most of the suits have been won by the company in the lower courts and have been carried up by the farmers. The company has won a case in the Supreme Court, where it was being prosecuted for maintaining a nuisance. It now appears that the farmers are lagging in their fight, perhaps because of lack of money.

The information given has been prepared, primarily, from notes taken at the reduction works by a member of the editorial staff of this journal, in May, 1899, in company with Mr. Geo. Geigele, President of the company, and Mr. E. D. Clark, Foreman, and from notes taken in Columbus in November, 1899, in company with Mr. Geigele. These earlier notes have been supplemented and brought down to date by later ones taken late in April, 1900, by Mr. B. H. Flynn, Engineer of the State Board of Health of Ohio. Mr. Flynn visited the works at our request, and made a careful examination of them. He acknowledges his indebtedness to Mr. John C. Curry, Superintendent of the company, for courtesies extended and information given.

When the writer of this article visited the plant in May, 1899, cooking was in progress in one digester and pressing in two others. Very little odor was noticed in the building or close by it. About 1,000 ft. to the windward quite an odor was noticeable, but not of an offensive character. There are a few scattered houses not far from the plant, but the company states that the people who have complained of the odors the most live a half a mile to a mile distant. As to the general sanitary condition of the works, Mr. Flynn wrote as follows, after his visit there in April:

The odor from the charging floor was very bad, but it was not noticeable when outside the works. . . . The only objectionable odors outside of the buildings themselves are from the oil tanks, settling basins, and outfall sewer. These give off a very rank smell, which, however, does not seem to be perceptible at any great distance. Inside the plant the charging floor gives off the worst smell. The general odor about the plant seems to me to consist of a sickening odor like burnt coffee, objectionable only on account of its strength and not on account of its character.

The facts seem to be that the company started out with an incomplete plant, located on a grossly polluted and (at times) malodorous creek; that the

plant may have given rise to offensive odors at the start, and was, and still is, debited with all the odors from the creek; that the ensuing litigation retarded necessary improvements for several years; that marked improvements have been made, of late, but still others are necessary, both for the most economical and sanitary operation of the works; and, finally, that much of the bad odor from the works is not incidental to this particular process, but is due to the green garbage as it is unloaded and sorted at the works.

MINING AND METALLURGICAL EXHIBITS AT THE PARIS EXPOSITION.

(Editorial Correspondence.)

The foreigner visiting the United States exhibit in the department of mines and metallurgy on the Champ de Mars, and otherwise ignorant of American industries, will probably conclude that the Colorado Fuel & Iron Co. is the principal rolling mill concern of the United States. This firm makes an excellent and creditable exhibit; but it is the only large company making rolling mill products which does. The American Steel & Wire Co. has a good exhibit, but it is almost wholly devoted to its various wire products. The Crescent Steel Co. has an exhibit of tool steels which will bear comparison with the similar exhibits of foreign firms here, and this is very high praise indeed.

In showing American minerals and mineral deposits very creditable work has been done by the Geological Survey. In fact we are indebted to the Government departments that we make as fair a showing as we do, not only here but at many other places in the Exposition. As an illustration of this, there is probably not a building on the grounds from which an American emerges with such patriotic pride as from the building devoted to tools and implements of warfare. Our exhibit is not large, but the beautiful models and photographs of the vessels of our navy and of our naval material which are there shown have nothing to fear in comparison with those shown anywhere else.

To return to our exhibit in the mining building. The best thing in the exhibit probably is the very fine collection of stones, ores, minerals, gems, etc., comprising exhibits by Tiffany & Co., the Foote Mineral Co. of Philadelphia, the Massachusetts Institute of Technology, Rogers, Brown & Co., and others. The American Institute of Mining Engineers maintains a headquarters in this section, with a reading-room where American engineering journals are on file, and the wall is adorned with a set of photographs of the past-presidents of the Society.

In the gallery is a very good display by a dozen makers of American tools and hardware—so good and with so much promise of "business" in it that it ought really to have had a place downstairs, where it would have had more visitors. Among the notable things here is a beautiful model of the Brooklyn Bridge, forming part of the exhibit of the Roebling Co. It is over 20 ft. in length and fully deserves a prominent place in the Civil Engineering Section, to make our display of bridges there bear better comparison with those of France and Germany and Russia. It may be of interest to note that this is the second model of this bridge which the Roebling Co. has built for the Exposition. The first one went down with the "Pauillac," and as soon as the loss of that vessel was known, work was at once undertaken on a duplicate, which was finished, rushed over here and put in place with remarkable dispatch.

Engineers who were in Chicago in '93 will certainly recall the fine display made there by the Swedish steel makers. The Swedish section here is equally interesting and the quality of material and workmanship there displayed, it need hardly be said, is of the very highest order. I do not know why these Swedish deposits of iron ore of wonderful purity and enormous extent might not be made as important a factor to Europe's iron and steel industry as the Lake Superior deposits have been to the United States. Perhaps this may yet come to pass, but at present the Swedish industry is notable for the quality rather than the quantity of its output.

In the exhibit of the Fagersta works in the Swedish pavilion is a case of 130 specimens of tool steel, broken to determine the influence of different constituents in the steel upon its hardening qualities. There were 13 different steels tested, and each steel was hardened at ten different temperatures, ranging from 620° C. to 1,200° C., and then broken to exhibit its fracture. The results of the investigation may be summed up as follows:

The appearance of the fracture and the strength and toughness of tool steel will vary according to the temperature at which it is hardened. If the temperature is too low, little or no hardening will take place. If too high, the crystals formed will be large and the metal will be brittle. The result desired is a fracture in which the crystals formed throughout the piece are so fine that they give to the fracture the well-known silky or satiny appearance. Now it is evident that the wider the limits of temperature between which hardening will take place with the production of this silky fracture, the more certain is it that good results will be obtained in the hardening process.

It is found by these and other tests that the various metalloid constituents exercise great influence upon the range of hardening temperatures of steels. The presence of phosphorus has a marked influence in narrowing the limits of hardening, so that a tool steel with high phosphorus will very likely be either too soft or too brittle when hardening is attempted. The presence of manganese and sulphur combined in certain proportions, on the other hand, tends to widen these

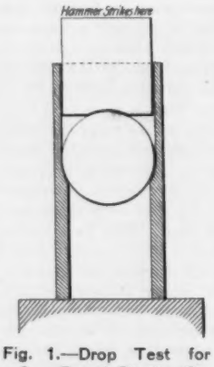


Fig. 1.—Drop Test for Gun Barrel Blanks, Fogersta Works, Sweden.

limits to a marked degree. Its influence is shown to the greatest degree in steels of very high carbon.

In the same company's exhibit there is shown a novel method of testing hollow steel blanks for gun barrels (Fig. 1). The tube to be tested has its bore enlarged for a short distance with a round-nose drill and a hardened steel ball just fitting the enlarged bore is dropped into it, as shown in the accompanying sketch. A plunger is inserted on top of the ball and a weight is let fall on the plunger. If the tube is of tough and ductile material, the walls will be bulged out all around evenly by the wedging action of the ball. If there are any longitudinal seams, however, the tube will split. It is a severe test, but a very neat one for its especial purpose.

While Sweden makes a fine display, as was to be expected, the exhibit of Norway is surprisingly small. Norway iron is so familiar a term in America, that one looks for a good display of the iron industry in the Norway section; but almost the whole of the not very large space is given up to exhibits of marble, granite and other minerals.

There are plenty of surprises of the opposite sort for Americans here, however. For example, it is safe to say that precious few Americans outside of those who have done more or less "globe-trotting" know anything about the Grand Duchy of Luxembourg, as an independent and "going concern." Yet this small nation not only has a space all to itself in the Mining Section, but in its exhibit there it is shown that this little country produced over 6,000,000 tons of iron ore in 1899, more than all France, and it possesses blast furnaces and rolling mills in proportion.

The great surprise of the whole mining section, however, is the exhibit made by Russia. Americans have been looking toward Russia as one of the great future markets for our export goods. We have been preparing to compete with Germany and England for it, expecting to have to "hustle" but expecting also to win. But it is entirely evident from the showing made here that it is going to be Russian manufactories with which we shall have to compete in sending goods to Russia. No nation here displays greater enterprise and greater pride in its manufacturing industries. Compared with the vast needs of the nation the present output of its factories is indeed small; but with such skill and brains and energy as the exhibits here display, enormous growth is certain.

The artistic skill displayed by these Russian workmen is marvellous. Several of the exhibits in the Matallurgical Section contain fine ornamental foundry work, statuary, etc., and there is also some beautiful work in wrought iron and steel decoratively treated. In the entire exhibit of pianos, with highly-decorated cases, the most beautiful instrument of all, to my mind at least, is a piano from a St. Petersburg maker, covered with fine carving done in a clear white wood which gives a most lovely effect.

This much merely to show the artistic ability to be found in that far-away land. Now here are two examples of a different sort of work. In one of the iron companies' exhibits is a model of one of its blast furnaces which is fitted with an automatic charging apparatus. It is not a very large furnace, according to American ideas at least, and automatic charging apparatus has been used in the United States more or less for ten years past. But the fact that a Russian ironmaster, notwithstanding his cheap labor, is adopting such up-to-date devices as an automatic stock hoist is certainly an indication of the progressiveness that characterizes the Russian of the present day.

The other example is an ordinary-looking corrugated furnace for an internally-fired boiler, shown in the exhibit of the W. Fitzner & K. Gamper Co. in the Mechanical Section. The interesting thing is the manner in which the corrugations are formed. The common method is to form these corrugations by a powerful and expensive machine, a patented process, operated by only a single firm in the United States. The corrugations in this furnace were made in a different way. The plain tube in which the corrugations are to be formed is placed in a hydraulic press and connection is made to an air compressor so that the interior of the tube is filled with compressed air at high pressure. Then at each point where a corugation is to be formed a ring of gas jets is placed to heat the tube all around at that point. When the heating reaches the point at which the metal is plastic, the hydraulic press is set in motion, the tube buckles at its weakest points, where it is plastic from the heat and the internal pressure forces it to buckle outward instead of inward. It seems almost incredible that so simple means could produce so excellent a result, but the tube is there to show for itself, and one advantage claimed for the process—the thickening of the metal at the top of the corrugation is evident on the section.

I cite this as an example of combined ingenuity and good workmanship; but in the same exhibit is a still more remarkable example of workmanship. It is a hollow iron sphere mounted on hollow trunnions and made of sheet metal with all joints welded, trunnions welded on. Not a seam to be discerned anywhere. The only openings, except the trunnions, are small manholes on each side. It is a huge affair, over 9 ft. in diameter, and the skill and patience required to execute such a job of welding can be imagined.

Still another remarkable example of welding—from Germany this time—is shown near the Army and Navy Building. It is a hollow reservoir with welded seams, throughout, not a rivet anywhere, and of herculean size. Its dimensions are: Diameter, 5 ft. 11 ins.; length, 65 ft.; heads, ⅝-in. thick; shell, ½-in. thick; total weight, 27,000 lbs.; test pressure, 284 lbs. per sq. in. This remarkable piece of work is from the establishment of Julius Pintsch of Berlin, the inventor of the well-known Pintsch gas system of car lighting exploited so successfully in the United States by the Safety Car Heating & Lighting Co.

We may as well confess that such feats of welding as this are not in the American line. No American firm would want to undertake such work, and no American customer would want to pay for the time and skill and patience necessary to accomplish it. Some other and cheaper way would be devised to accomplish the desired end; and if I mistake not this is really a typical difference between American and European systems of production.

Returning to the Russian exhibit in mining and metallurgy, it may be noted that among the rolling mill products shown are I-beams up to 20 inches. Some well-designed gang-plows are evidence that Russian agriculture is not wholly in a primitive state.

No less interesting than the iron working exhibits are those of coal mining and petroleum industry. Russian petroleum production is now slightly in excess of the American in volume. In the exhibit of the Gorlowka coal mining company, which now produces 700,000 tons of coal per annum, one interesting feature is the provision made by the company for its employees. Photographs are shown of the bathhouses provided for the miners on coming from their work, and very neat and well kept they appear. Still more interesting photographs show the exterior and interior of miners' cottages, and if they are at all representative the homes of these Russian miners will compare more than favorably with some of the mine tenements in Pennsylvania and parts of the South, I am sure.

A notable feature throughout the foreign mining displays is the amount of briquettes shown. It appears to be very common practice among the mining companies to make briquettes of such coal as is too fine to burn in a grate, and it is reported an excellent fuel. One English manufacturer informed me that in his practice pitch is used to cement the briquettes together, and is made by distilling coal in retorts at the mines. These briquettes are used both under boilers, for locomotives and as household fuel.

The display of Great Britain is small here, as everywhere else in the Exposition, and it is especially so when her predominant position in the mining and metallurgical industry is considered. Compared with her annual output of some 220,000,000 tons of coal, Continental coal mining operations are small. Some of the Welsh anthracite companies have exhibits here, and it is interesting to notice how the names for the different sizes of coal vary from our own. Their "cobbles" corresponds fairly well with our "furnace"' size. One can readily understand why it would not be called "furnace" coal in a land where a house heating furnace is a curiosity. Our "stove" size is "huts" in England. "Chestnut" is "beans," and then comes "peas" and "duff." The sizing is very poor on all the samples, especially on the small sizes, partly owing to the fact that the coal appears to break in long pieces and not in roundish lumps like American anthracite.

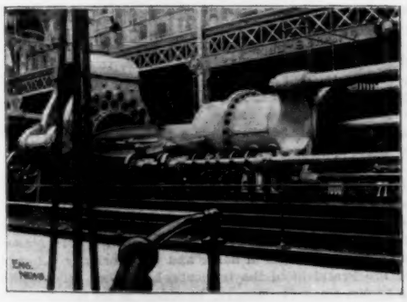


Fig. 3.—Cylinders and Valve Gear of 700-HP. Gas Engine.

Holman Bros., of Camborne, Cornwall, England, exhibit a model of a novel arrangement of winding engines. To prevent the winding rope from overlapping on the drum and also avoid the "angling" of the rope as it runs from the head pulley to the drum, the whole engine is mounted on wheels and traverses back and forth on rails parallel to the axis of the winding drum. This system has been applied to a 24 × 60 duplex engine with a drum 10 ft. in diameter and 21 ft. long at a Cornwall mine. This engine hoists 72 tons an hour from a depth of 3,000 ft.

There is a French winding engine on exhibition here in connection with the subterannean mine exhibit in the Trocadero section, which is doubtless a good example of first-class French work in this line. It is a big four-cylinder duplex compound of 3,000 HP. Instead of a long drum there are two spools, and a flat manila rope is used 16 ins. wide. This is wound on the spool in successive layers. The French appear particularly partial to flat ropes for hoisting work. They even use them on elevators in buildings. The flat rope system has the advantage that the changing leverage as the rope winds in and the diameter of the winding surface is thus increased compensates for the reduced amount of cable that has to be lifted. The trouble is that it compensates too much, and the hoisting machine sometimes gets stalled with the load part way up the shaft.

Another thing of interest in the French mine exhibit is an automatic grip arrangement for mine hoisting cages, used by the firm of P. Malissard-Paza, of Anzin, France. The guides in the shaft are steel rails of standard section, and a pair of steel cams with serrated teeth on a concave face are set to embrace the rail head on each side. When everything is lovely the smooth face of the cam is close to the rail, but not in contact with it. Slackening of the rope turns the cam only a few degrees, but enough to bring the teeth against the rail head with great force. Tests are reported of this device in which a loaded cage weighing 22,900 lbs. was let fall. The distance which it fell before the grips brought it up varied in seven tests from 14 to 73 mm. (half an inch to 3 ins.). The rails which were gripped are also shown with the tooth marks on them.

Probably the most instructive and valuable exhibit to American mining engineers here, however, is the use of centrifugal pumps under high heads. Something in this field has been done already on our Pacific coast, but more appears to have been done here. The famous Swiss firm of Sulzer Bros., of Geneva, shows a pump with a capacity of 1,700 gallons per minute, forced against a head of 100 meters. It is directly connected to an electric motor, no belts or gears or jack shafts to give trouble, and is designed to run at 900 revolutions per minute. I am informed that some of these Swiss centrifugal pumps working under high heads show efficiencies above 80%. I do not see why such a combination does not furnish the ideal way of applying electricity to mine pumping, and under many conditions the ideal system of mine pumping anyway. A pump with no rubbing surfaces, no valves, no stuffing boxes—nothing to corrode by the acid mine water, or wear out—furnishes just what mine managers want or ought to want, and it will be strange if some enterprising makers of centrifugal pumps or electric motors do not educate them to the possibilities in this direction.

It should be said that such very high speed is not essential to high lift in centrifugal pumps. In the French exhibit a mine machinery manufacturer shows a centrifugal pump for working against a head of 112 ft., and it is compounded, the first spiral delivering into the second.

Ranking in interest and importance with these centrifugal pumps, however, is the big gas engine for blowing blast furnaces, exhibited by the John Cockerill Co., of Seraing, Belgium. It is a huge machine whose general appearance is fairly shown in the accompanying cuts (Figs. 2 and 3). As will be seen, it is a horizontal single cylinder engine with the blowing cylinder on the same rod back of the gas cylinder and fitted with ordinary poppet valves. The valves of the gas cylinder are driven by cams on a side shaft, the arrangement being quite similar to that in use on gas engines of ordinary size. The row of small eccentrics, seen to the left of the large cams in Fig. 2, operate small oil pumps which force oil to various rubbing parts.

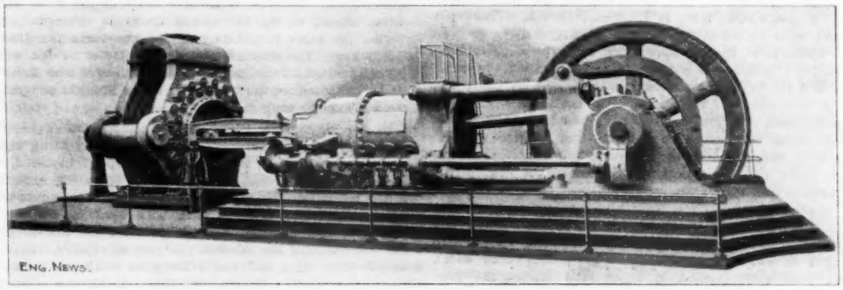


FIG. 2.—700-HP. GAS ENGINE FOR BLOWING BLAST FURNACES.
(Exhibited by the John Cockerill Co., Seraing, Belgium, at the Paris Exposition.)

The engine will develop 700 HP. with blast furnace gas or 1,000 HP. with city gas. It uses the latter in the Exposition of course, but has to run without load. It operates as quietly and smoothly as a steam engine.

The mistake is sometimes made of supposing that European engineers and manufacturers are slow to take up new ideas. This machine illustrates the falsity of that idea. The first of these big blowing gas engines was built by the Cockerill Co., and set at work in November, 1899, and since then this company and its licensees have booked orders for 71 similar machines. It is estimated that a blast furnace making 100 tons of iron in 24 hours will produce gas enough to develop 2,800 HP., of which 800 HP. will be sufficient to drive its blowing engines, and the remaining 2,000 HP. can be used to generate power for sale.

Such a departure as this is of the greatest interest to such American industrial centers as Pittsburg, Chicago, Buffalo, Troy, and many other places where a ready market is at hand for the surplus electric power which blast furnaces could readily furnish. From the iron manufacturer's point of view, the income from the sale of power should increase his gross earnings from 15 to 25%, and the entire elimination of the boiler plant will mean a great saving in the annual expense and repair account.

ENGINEERING AND ENGINEERS.*

The profession of civil engineering, as we now know it, is a child of the nineteenth century. The conception of that child, however, occurred with the earliest dawn of human history. The ancient engineering profession, by whatever name we may call it, probably achieved its highest distinction during the existence of the Roman Empire, through the efforts of the legion of engineers whose names have sunk into oblivion but the remnants of whose works remain until to-day. The profession, however, has only reached its present strength and vigor during recent years.

No one agency has been a more potent factor in the advancement of civilization than improved transportation facilities, and the profession of civil engineering has been the force which has conceived, designed and executed the works and machinery which have furnished the world with these facilities. There is hardly a branch of the profession which does not touch on the principle of transportation. The great engineers of this century have been responsible for and should receive credit for the con-

*Abstract of the address delivered by Mr. John F. Wallace, President of the American Society of Civil Engineers, at the annual convention, held at the hall of the Institution of Civil Engineers, London, England, July 2, 1900.

ception, design and execution of these works, without which the Americas, Asia, Africa, Australia and the isles of the sea would still be among the uncivilized, unknown or inaccessible portions of the world.

It behooves us, however, as members of this noble profession, to realize the responsibilities resting upon us and appreciate the magnitude of the labors before us, and to prepare ourselves for the task; and in doing this to carefully observe our past failures and shortcomings. We should realize that our future success depends upon our full knowledge and appreciation of our past errors. We should discover those qualities in which we are lacking, and endeavor to supply and supplement our deficiencies, in order that we may be better fitted to assist our profession in successfully following out its manifest destiny.

The pioneer engineers of the century were strong, rugged characters, educated in the school of adversity, who lived close to Nature's heart and were keen observers of natural phenomena. They possessed strong imaginations, daring originality, faith in their convictions. These pioneers were followed by a class of engineers who were the students of their predecessors, and who supplemented their own talents and advantages by a study of the methods and the fund of knowledge accumulated by those who lived before them. This latter class has been followed by a generation of engineers who have had the benefit of the larger fund of accumulated engineering wisdom and experience, supplemented by academic and technical education; until now, the young man choosing the engineering profession has before him opportunities, easily accessible, of acquiring the highest scientific and technical education, and entire libraries devoted to the description and elucidation of engineering works and methods, from which to gain an accurate knowledge of the great works which have been accomplished by other members of the profession in all countries, and from which he can derive material for the formation of his own plans.

It has generally been understood that mathematical ability of a high order is a fundamental requisite to success in the engineering profession. This is not necessarily true, as it frequently happens that the person in whom mathematical ability of the highest order exists, is deficient in other essential qualities. While the successful engineer should be a good mathematician, should be a man of integrity, industry and resources, there are other qualities which cannot be ignored. The engineer who constructs a bridge, no matter how carefully he may design and construct his masonry foundations and steel superstructure, would not be considered an engineer, in the true sense of the term, should he neglect the hidden vein of quicksand, which might eventually cause the destruction of the entire bridge.

Among the underlying qualities necessary to the highest success in our profession are the ability to accurately observe natural phenomena; a faculty of mentally picturing things in their proper relation to each other; good business judgment and sense; a careful study of business methods; tact, which to some men means so much and to others so little; personal loyalty, not only to the enterprise in which he is engaged, but also to his immediate superior; and, above all, the engineer should not neglect the fact that "the proper study of mankind is man."

In the technical schools of the present day much time is spent in considering the strength of materials, the applied mathematics in the investigation of forces; but nothing in relation to the mental and moral constitution of man, which is the live material that engineers must use in fitting Nature's raw products to the work in hand. There is too much of a tendency among engineers to-day, as ever, to consider the profession entirely a materialistic one, and to confine the education of the young engineer to a knowledge of materials, and their uses, to the exclusion of the mental and spiritual. The prevailing law of matter is inertia. The prevailing principle of the engineering profession is life. The application and direction of the life principle to matter, in order to overcome its inertia, change its form and adapt it to our needs, is the problem. Neither factor can be ignored, above all the life principle. There is a disposition on the part of our profession to value too highly what are the tools of our trade; to forget for a moment that they are simply tools, and fail to appreciate the energizing factor and the mental make-up of the engineer.

It is not the most expert bookkeeper who becomes the most successful banker or merchant, no matter how important carefully kept accounts may be to the success of a bank or mercantile business. It is not the surgeon who has the finest set of instruments, or even the greatest knowledge of their uses, who is necessarily the most successful. It is not the lawyer who has read the most law, but the one who can discriminate and apply his knowledge to the case in hand, who is the best jurist. So it is not the engineer who is the most expert mathematician, the finest draftsman, or who may design and calculate the most beautiful structure, who is the most successful. The true engineer of to-day is the one who, seeing a necessity arising in the onward march of civilization, can think out its solution, conceive a project, design the necessary works connected therewith, and carry out the scheme as a whole to a successful issue; at the same time convincing his fellow-men of the necessity for the work, the efficiency and economy of his design, and his own ability to accomplish the desired result.

The surplus labor of the past is the capital of to-day. The conservation and preservation of that capital is a necessary factor in promoting modern civilization. Our works should increase the comforts of mankind, "cause two blades of grass to grow where one grew before," enable persons and property to be carried greater distances in shorter periods of time, with increased comfort and convenience and at the least possible expense. The economy of labor should be the ultimate object to be attained.

The best engineer is not necessarily the one who will design and construct an elaborate bridge across a mighty river, but the one who will design and construct such bridge so as to give the greatest amount of facility for transportation over it at the least possible expense. I have in mind a bridge over a great stream in America which, with its auxiliaries, was constructed some years ago at an expense approximating $10,000,000. It brought a national reputation to its engineers. I have in mind another bridge, located within five miles of the same structure, which, so far as railway traffic is concerned, performs the same functions but cost one-tenth the amount of money. The construction of this latter bridge was a mere incident in the career of the engineers who designed and superintended the work, and it has brought practically no addition to their fame.

In comparing the works of engineers, that engineer is the best who designs and constructs, results being equal, in such a way that the interest on capital invested, together with maintenance charges and operating expenses, are a minimum. It is certainly poor engineering to construct works so massive and with such a surplus of strength and solidity that the interest on the original amount invested far exceeds the cost of repairs, renewals and interest on a differently designed work which would perform a similar service. In this I think the engineers of the Old World can learn from those of the New. On the other hand, in the construction of works of a permanent nature, so as to reduce the cost of operation, maintenance or renewal, the New World can certainly learn from the Old World. During the past century, however, the problems which have confronted the engineers of these worlds have been vastly different. Works have been constructed in the Old World to meet existing and stable conditions; in the New World, works have been provided to create conditions; consequently, it has been necessary for engineers in the latter to have not only vivid and correct imaginations, and to be able to judge the possibilities and future requirements, but to design and construct their works in such a way as to bring about the desired results with a limited amount of labor and capital.

It has not been a question of choice between what was best or even most economical; the main question has been one of what it was possible to do under the circumstances. Frequently, it was a case of the engineer creating the circumstances. Conditions, however, are rapidly changing, and the engineer of the New World is following closely in the footsteps of the Old World engineer, and his works are gradually becoming more substantial and permanent.

While it is not only desirable, but necessary, that the independent units of our profession, in the form of the individual engineer, should reach the highest state of efficiency, it is also necessary for the highest success that these units be combined. In the engineering profession, the engineers of the British Empire have organized the Institution of Civil Engineers and made it the leading engineering organization of the civilized world. The last half of the century has seen the birth and vigorous growth of our own organization, the American Society of Civil Engineers. Engineering organizations in France, Germany and other countries have also brought engineers together and tended to advance the standard of our profession. In America, numerous local organizations have been perfected at secondary centers of population, which have done much to furnish engineers within their environment with the encouragement and strength due to association with their fellows. A strong tendency has also existed to form societies in the line of special engineering. These different organizations all have their functions. They are, however, restricted in their influence, and while engineers may be and should be benefited by a connection therewith, they should not forget that the American Society of Civil Engineers construes the term "Civil Engineer" in its broadest sense, and embraces all specialties and subdivisions of the engineering profession. While a connection with local or special organizations may benefit the individual engineer, the greater measure of benefit to the profession at large can be derived from affiliation with the more representative national body. It is through the national organization that we must expect to secure proper recognition for our profession.

Engineers in America do not appreciate the importance of this subject as fully as they should, or as much as their English brethren do, but they are becoming rapidly educated in this direction. As an instance of this, several years ago an engineer was sent to Australia in the interest of an American bridge company. He asked for a hearing before a certain commission which had charge of an important piece of engineering work. The first question asked him was, whether he was a member of the Institution of Civil Engineers of Great Britain. He replied that he was not. He was then asked if he was a member of the American Society of Civil Engineers. He gave a like answer, after which there fell upon the company a silence that impressed him with the fact that he would have no standing as an engineer in that country unless he was connected with one or the other of these great bodies. I cite this instance in order to impress not only upon the members of the Society but upon American engineers generally, the importance of the fact that these organizations have a higher standing in the eyes of the lay public than they sometimes have in the eyes of the individual engineer.

The point I desire to make and emphasize is the importance and responsibility of the engineering profession in relation to the advancement of civilization, and the fact that it is our duty, first, to fit ourselves as individuals in every possible way for the responsibility placed upon us, and secondly, that we should combine individual effort in organization; that it is the duty of the engineer first to fit himself for his individual work, and next to combine with his fellow engineers for the strengthening and elevating of the profession. From time to time much has been said in relation to engineering ethics, and suggestions have even been made that they be formulated. We should not forget that engineering ethics are simply business ethics, and that the foundation of all ethics is the golden rule, which we should individually endeavor to observe and practice.

THE LONDON CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The 32d annual convention of the Society was opened on Monday, July 2, at the house of the Institution of Civil Engineers, in London. Besides the 50 or more members of the Society who were present, many of them accompanied by members of their families, there was a good representation of members of the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers.

At 3 p. m. the visitors assembled in the Library of the Institution, where a speech of hearty welcome was made by Sir Douglas Fox, President of the Institution of Civil Engineers, on behalf of that organization, the Institutions of Mechanical and Electric Engineers, and the Iron and Steel Institute. Members of the Councils of all these societies were upon the platform, and it was noticeable that there was hardly a young or even a middle-aged man among them. The English societies evidently hold to the ancient maxim, "Old men for counsel." The Americans, on the other hand, were even more youthful than the average assemblage one would find in the house of an engineering society at home, and the contrast between the two bodies of men was perhaps more or less typical of the nations which each represented.

Sir Douglas' welcoming speech was replied to briefly by Mr. John F. Wallace and Mr. H. S. Haines, on behalf of the American Society of Civil Engineers, and by Mr. Jesse M. Smith for the American Society of Mechanical Engineers; and afternoon tea was then served, according to the English custom.

It should be said here that the members and officers of the British societies were most cordial in their personal greetings to their American guests, and not only on this first day, but throughout the meetings, every attention and hospitality was shown the visitors, who were made to feel that their presence was a pleasure and not a burden to their warm-hearted hosts.

It may also be mentioned that the hospitalities of English engineering societies to American engineers really began the week previous with the meeting of the Institution of Mechanical Engineers of Great Britain. At the first session the American engineers who were present were given the seats of honor and were formally welcomed by the President of the Institute, his speech being replied to by Mr. Chas. H. Morgan, President of the American Society of Mechanical Engineers. Afterwards the Americans attended such of the meetings as they desired, and joined an excursion to the famous engine-building works of Willans & Robinson, at Rugby.

It may be set down here, for the information of American engineers who may have to conduct the entertainment of similar parties, that a unique plan was adopted for conducting the visitors through this famous works.

As everyone knows who has had anything to do with such entertainments, if a large party is to be conducted through an establishment so that all can see the things of interest without crowding, it is necessary to divide the party into small squads of a dozen or so, each with its own guide. The trouble usually experienced, however, is that the different squads become mixed up, and confusion at once results, and the final result is that half the party becomes separated from their guides and struggle along as it happens, missing many of the things of especial interest.

At Willans & Robinson's, each squad was given a set of miniature colored flags, one for each member, which could be pinned to the coat. The guide of each squad was given a large flag of the same color, and all any one had to do to keep with his own squad was to follow his flag, which was kept displayed by the guide so that any member could readily find it and catch up with his party after a stop alone to examine something of especial interest. All mix-

ing of different squads was also obviated. The plan worked to perfection, and is worth adopting by American engineering societies, as a standard plan for their summer excursions.

The first formal session of the American Society of Civil Engineers was opened at 4 p. m. in the theatre of the Institute, after the tea above referred to had been dispensed, and was devoted to the annual address of the president, Mr. John F. Wallace. The address is printed elsewhere in this issue, and lays down some sound principles relating to the present and future development of the engineering profession.

High Buildings and Restrictions Upon Their Height.

For the evening session, the topic chosen was the question whether the height of buildings should be restricted by legislation, or whether the advances in engineering science had been such that all such restrictions might be safely done away with. The topic was opened with a contribution by **Mr. C. T. Purdy, accompanied by lantern slides** showing some notable high buildings of New York and Chicago, which while familiar to most of the American engineers present, were novel and highly interesting to most of the English engineers.

Mr. Purdy, after recounting the various objections raised to the "skyscrapers," expressed his belief that most of these objections did not apply to buildings not more than 14 or 15 stories in height, and properly located and constructed. He pointed out that the new buildings are much better than the older ones, and obviate many objections which were raised to them.

In conclusion, he showed that while the American has developed the high building, it is really of European invention. Back in the 50's an English engineer named Pritchett built an asylum with fireproof floors made with hollow terra cotta blocks between iron floor beams. Cast-iron beams were used, wrought-iron beams being not then rolled. The arches had a span of 4½ ft. The first building in the United States with hollow terra cotta floor arches was not erected till the 70's.

A written contribution to the discussion was read from Mr. R. P. Bolton, and curiously enough, although Mr. Bolton is an English engineer, resident in New York for some ten years past, he was the only one taking part in the discussion who favored the entire abolition of all legal restrictions upon the height of buildings. He held that the inconveniences and objections raised to high buildings were more imaginary than real, and that so far as they were genuine, they were outweighed by the great public benefits accruing from their construction.

President Wallace said that the business aspect of the question had been the governing one in the construction of high buildings. The high buildings of Chicago had cost to construct 30 to 40 cts. per cu. ft., and the office space in them rented at $2 to $2.50 per sq. ft. Mr. R. W. Hunt described the Rookery Building, one of the first high buildings in Chicago, and remarked that it had never paid its owners less than 12% on their investment.

President Wallace then asked Sir Alexander Binnie, Engineer to the London County Council, to explain the European view of the high buildings. Sir Alexander said that he considered the question one of architecture rather than engineering. He did not doubt that in suitable locations the resources of engineering science were sufficient to overcome any difficulties that might be met in the matters of constructing, heating, lighting, ventilation, etc. It had been said that high buildings were a necessity in congested areas. There is hardly a more congested area in the world than the old City of London—a space about a mile square in the heart of London where all its great financial interests are concentrated. Yet he could not favor high buildings for such a space, for with the very narrow streets, air and light would be almost wholly excluded.

Mr. Edward Riley, Architect of the County Council, was next called on and gave an interesting resume of European building laws. He did not doubt that American high buildings paid, but Europeans approached the matter from a different standpoint. European laws invariably require the supporting walls to carry the structure, which precludes the use of steel-column construction. As to the height, the London building law fixes 80 ft. as the maximum height of a building cornice, and on streets 50 ft. or less in width aims to preserve a clear sky line at an angle of 45° to each side of the street. That is to say, the height of the building must not exceed the width of the street. In Vienna, buildings must not exceed 82 ft. to the cornice, or 66 ft. to the top floor. In Paris the height is fixed according to the width of the street, with 66 ft. as the maximum.

Mr. Harry de B. Parsons then presented a series of lantern views, showing the effects of fire on various forms of construction, non-fireproof, as well as fireproof, and explained some of the principles which govern first-class fireproof construction in the latest and best practice. The views shown, included such notable American fires as that at the Windsor Hotel, the Home Life building, the Horne store in Pittsburg, and the Washburn & Moen factory in Worcester, and while very interesting, were hardly calculated to incline the English engineers present to a favorable consideration of high building construction.

Tuesday's Session.

Two subjects were scheduled for the session on Tuesday forenoon: "Rail Manufacture," and the "Filtration of Water," either of them topics sufficiently large to occupy a whole session. The former topic was opened by Mr. R. W. Hunt in a long and very interesting paper, chiefly historical in its character. With reference to present practice, he favored an increase in the amount of carbon in proportion to the weight of the rail, and also the finishing of the rail after its temperature has been much reduced. For testing he advocated drop tests and chemical analyses from each heat of steel; but saw no need for the static, tensile and elongation tests on which European engineers insist.

Mr. Albert Ladd Colby, of the Bethlehem Iron Co., followed Mr. Hunt with a carefully prepared paper in which he set forth the reasons why European engineers may safely modify their specifications to conform to ordinary American rolling mill practice and thereby enable their customers to purchase American rails at much lower figures than the mills can name if some of the features of the European specifications are insisted on.

Mr. Wm. R. Webster urged that the American Society should take up and modify its series of standard sections for rails, with a view to making a thinner head, and a thicker flange and web. With the present sections, the flange cools most rapidly and determines the heat at which the rail can be finished, and the head of the rail is still at too high a heat for the best results when it finally leaves the rolls. Some metal ought to be taken from the head and transferred to the web and flange. He thought that the requirement of an increase of the carbon percentage in the heavier rails had not been wholly justified by results.

President Wallace said that up to the present time, American railway companies had had comparatively little to say as to the specifications and the quality of the rails which they used. Commercial and business considerations had governed in the purchase of rails and the roads had been obliged to take what the mills would furnish. At present the rail-producing capacity of the United States is almost wholly in the hands of the two great combinations, the Federal Steel Co. and the Carnegie Co. This condition is to be met, however, by a combination among the purchasers of rails. A committee of railway engineers is now preparing a standard specification for rails, which is designed to require what the mills can furnish by first-class work, without embodying requirements which will increase cost or difficulty of manufacture without corresponding improvement in the quality of the product. He then called on the venerable Sir Lowthian Bell, now over 80 years of age, to continue the discussion. It is a noticeable illustration of the vigor of the older men in this country that Sir Lowthian, notwithstanding his advanced years, still continues in active life, and referred at the outset of his remarks to his long service, still continued, as a director of the Northeastern Ry. He described the extensive investigation made by that company to determine the relation of the composition of rails to their service, and declared that as a result of over 35,000 chemical analyses, he was in position to either prove or disprove any statement whatever respecting the relation of the composition of rails to their wearing qualities.

One point of interest brought out in the discussion was the fact that low phosphorus does not appear to have the importance in rail steel that has been supposed. European specifications generally call for phosphorus to be 0.06% or less; but American mills increase this limit to 0.10%, and nearly all American railways accept such rails and they are giving good results in service. Both Mr. Wallace and Sir Lowthian Bell gave instances where rails which had given exceptionally long service were analyzed and found to be very high in phosphorus.

In closing the discussion, Mr. Hunt stated that both the Edgar Thomson and South Chicago works have plans prepared for alterations to their mills which will enable them to finish all rails at a low heat, and these alterations will be made as soon as a let-up in the market permits the works to be shut down long enough for the changes to be made.

The Filtration of Water.

This topic was opened by Mr. Rudolph Hering, with a short paper in which he summarized the present "state of the art," in the United States. Briefly described, there are two principal systems of water purification, the slow sand filter in which the water passes down through the sand layer at a rate of 2½ to 5 ins. in depth per hour, and the rapid or mechanical filter in which the speed of downward flow is about 8 ft. to 16 ft. per hour. There is also the Worms system in which porous tiles are used, but the surface of these becomes clogged so rapidly that it is only suited to a clear water. In the Maignen system the filtering surface is covered with an asbestos cloth, which intercepts a good part of the impurities and the filter can be cleaned by rolling up this covering material.

The slow sand filter operates both by a straining process and a bacterial process. The rapid, or mechanical filter, by straining alone, a thick gelatinous layer being formed on top of the sand by the introduction of a coagulant.

The efficiency of slow sand filters depends first on the size of the sand grains. A uniform small size produces the best results. Secondly, on the rate of filtration. Third, on free drainage, producing a uniform head on the filter. Fourth, on a uniform temperature, as the bacterial efficiency falls off rapidly with decrease of temperature. This makes necessary the covering of the filters. Both continued and intermittent filtration have given good results; but the latter is only needful where the water is low in dissolved oxygen and aeration of the sand bed is required. Settling basins are a necessary adjunct to sand filters where the water carries much matter in suspension and a coagulant must be added where very fine clay is present, if a clear water is desired.

The rapid or mechanical filters can give equally high bacterial results with the slow sand filters, but are more likely to irregularities in working, and on that account the slow sand filters should be chosen for highly polluted waters.

Which system should be installed in any given case will depend on local circumstances, and the relative cost under the conditions present.

Mr. Wm. H. Lindley was called upon to continue the discussion, and exhibited some charts showing a filtration system which he has recently installed for the city of Warsaw, and which may be taken as representing the latest European practice. The river water there used is quite highly polluted and settling basins were installed. These are divided into compartments by longitudinal walls, and there is a distributing arrangement by which the water enters a duct at the bottom of the receiving end, in each compartment. At the opposite end the water discharges over a broad weir. Thus a uniform flow is insured throughout the reservoir, and the velocity is about 1 mm. per second, or 12 ft. per hour.

This arrangement secures the desired end very perfectly except when the entering water is colder or warmer than the water in the reservoir, when there is a tendency for the colder water to flow on the bottom, or the warmer water to flow on top. To meet this, there are cross walls in the longitudinal compartments with openings at top and bottom, so that cold water can be discharged on top or warm water at the bottom.

There are also arrangements by which the head on the beds is kept uniform, and by decreasing the thickness of the gravel and increasing that of the sand an improvement in the bacterial efficiency of the filter has been made. Thorough ventilation is provided for by building ventilating shafts of some height, which act like chimneys, and the fresh air is delivered at the water level; thus the stagnation of air is prevented and the interior of the filter is kept sweet and fresh.

Excursion to Windsor Castle.

The state apartments at Windsor are not open to the public when the Queen and Court are in residence there. It was announced by Sir Douglas Fox at the opening session, however, that when the Queen was informed of the visit of the American engineers, who would naturally desire to visit Windsor, she at once said that the castle should be opened to them, and directed that refreshments should be served during their visit.

A special train of corridor cars was in waiting at the Great Western station on Tuesday afternoon to convey the party to Windsor, each car was liberally supplied with fruit and flowers, through the courtesy of the Institution. The afternoon was fine and clear, so that the picturesque scenery along the line was seen to the best advantage, and it was hard to say whether the attractions without or within the cars were most to be admired.

At Windsor, between one and two hours were spent in examining and passing through the great labyrinth of rooms in which are displayed the treasures of art and the museum of curios and antiquities, which has been here collected, and in admiration of the noble proportions of the great structure itself, and of the surpassing views from its windows and terraces. The party then assembled in the orangery, where the American engineers, for the first time in the history of their respective societies, were able to partake of a Queen's hospitality. It may be safely said that no more daintily served and pleasing luncheon was ever spread for the entertainment of an American engineering society.

After the luncheon, the party crossed the lawns in front of the East Terrace and formed in line along one of the roadways. Soon from the gates of the castle came an open carriage with the Queen herself. The carriage stopped near the head of the line, and Sir Douglas Fox presented to the Queen, Mr. Wallace, President of the Civil Engineers, and Mrs. Wallace; and Mr. Morgan, President of the Mechanical Engineers, and Mrs. Morgan. The Queen expressed her pleasure that the weather had proved so propitious for the Americans' visit. Three hearty American cheers were called for by Sir Douglas, and were given with a will, and the carriage then drove slowly along the line, the Queen bowing and smiling in response to the enthusiastic greetings of her visitors.

After some further exploration of the castle, the party returned to the station, where the train was in waiting to convey them back to London.

No meetings were scheduled for Wednesday, the 4th, it being deemed best with reference to the events of a century and a quarter ago and in courtesy to our present hosts to leave the members of the party to celebrate the day each in his own way.

Thursday, July 5.

The annual business meeting of the society was opened at 10 a. m. with the announcement of the results of the informal letter ballot for members of the nominating committee which this year, by reason of the very small number of members likely to be present at the annual convention, was decided upon to take the place of the usual complicated system of holding separate "caucuses" of the members present from each geographical district.

In district No. 1, the number of ballots cast was 72, of which Mr. Nelson P. Lewis, of Brooklyn, received 32 votes and Mr. R. S. Buck 21, the remainder scattering. Mr. Lewis was nominated and elected.

In district No. 2 there was 55 ballots cast, of which 30 were for Mr. F. S. Curtis, of New Haven. On behalf of the Boston members, however, Mr. F. K. Stearns was nominated on the ground that the holdover member from this district is an officer of the New York, New Haven & Hartford R. R., and it would be unwise to choose another member from this company. Both Mr. Stearns and Mr. Curtis were balloted for by a show of hands, and the former was chosen by a small majority.

In district No. 3 there were 16 votes cast, no one candidate receiving more than 2. Mr. E. B. Guthrie, of Buffalo, was elected.

In district No. 4, 17 votes were cast. Mr. L. Y. Schermerhorn, of Philadelphia, received 4, with the others scattering. Prof. Edgar Marburg, however, was nominated and elected.

In district No. 5, Mr. C. L. Strope, of Chicago, received 10 out of 29 votes cast, and he was nominated and elected.

In district No. 6, Mr. J. M. Johnson, of Louisville, received 11 out of 33 votes, but Mr. Edward Flad, of St. Louis, was nominated and elected.

In district No 7, 22 votes were cast, and Mr O. J. Tullock, of Leavenworth, Kan., was nominated and elected.

The result of the annual informal ballot for the time and place of holding the next annual convention were announced by Secretary Hunt. There were 180 votes cast, of which Buffalo received 40 and Chicago 10, the remainder badly scattered. As to time, 82 favored June and 44 July.

The proposed amendment to Article VII., Sec. 2, of the Constitution, was then taken up. The amendment has already been brought before the members by circular. It effects a radical change in the manner of selecting the nominating committee and making nominations. It was voted to submit it to letter ballot.

A resolution was offered and adopted extending the thanks of the society to the French Society of Civil Engineers for its entertainment of the delegates from the American Society at its recent meeting. A committee was also appointed to draft suitable resolutions of thanks to the Institution of Civil Engineers and the other organizations which had extended hospitalities to the society during its sojourn in England.

The Filtration of Water.

The discussion of the subject of water filtration, adjourned from Tuesday, was then resumed and an English engineer was called on to present his views on the subject. He said that while by far the largest development of filtration works has taken place in Europe, the old world is really indebted to America for much of its knowledge on the subject of filtration. The experiments of the Massachusetts State Board of Health, and the more recent ones at Louisville, Pittsburg and Cincinnati, furnish the most accurate data in existence on the subject.

An interesting question is as to the part played by the sand layer in the filtration process. In his opinion, the sand bed is little more than a strainer and support for the surface film, and when the latter is in proper condition, the sand is doing little or nothing. It is necessary, however, to have a considerable thickness for the sand layer to provide for cleaning. Also, if the surface of the film is anywhere injured, the water that goes through unpurified, will be much less with a thick sand layer than with a thin one. Again, he had found that there is considerable motion among the sand particles. The water does not pass vertically downward through the sand, but flows in fine filaments in every direction, and its velocity in the fine interstices between the sand grains is really considerable. With thin sand beds, there is more movement of the sand and more tendency to sorting of the sand in coarser and finer layers. To avoid this, it is best to use very fine and uniform sand.

In the management of a filter ignorant men too often resort to all sorts of expedients to make the water go through faster. To give a ready check on the condition of the filters and the character of the water passing, he has installed an automatic recording meter which registers graphically the rate of flow from each filter. Any injury to the film on any part of the filter beds or any irregularity in their working will be at once recorded on this meter, and the supervising authority can thus assure himself every day of the correct operation of the plant.

Mr. Geo. W. Fuller was next called on and gave an interesting summary of the varying character of the waters of the United States for which filtration has to be provided. For the clear waters of the glacial region, sand filtration is doubtless the best process, especially where sewage-polluted streams are to be dealt with. For waters from which vegetable stains must be removed or for the Western and Southern waters containing a large amount of suspended matter, a coagulant is necessary, and where this is applied a mechanical filter gives better results than a slow sand filter. The trouble in using coagulant in connection with slow sand filters is that some of the coagulant is likely to pass from the settling basin to the filter and it clogs it up very rapidly, necessitating frequent cleaning. A mechanical filter, on the other hand, can be rapidly cleaned whenever necessity requires.

In treating waters carrying large amounts of suspended matter or vegetable stain, constant changes are necessary in the dosing of coagulant to suit the varying condition of the water. With the mechanical filter it is possible to add a further amount of coagulant as the water leaves the settling basin and passes to the filter, in case clarification has not been completed in the settling basin. With the slow sand filter, however, this cannot be done, for the reason already stated.

Concerning the rate of flow, some recent small experimental filters have given good results with a rate of 5,500,000 to 7,000,000 gallons per 24 hours; it is probable, however, that such rapid filtration could only be made successful with water not seriously polluted.

As to covering filters, there has been a sort of rule that they need not be covered where the mean temperature of the coldest winter month is above 32° F. In view of the occasional exceptionally cold winters, however, Mr. Fuller believed that covering was advisable in almost every locality in the United States where slow sand filters would be installed.

In conclusion he said that no term yet suggested to designate the so-called rapid or mechanical filtration was entirely satisfactory. He objected to any term which related to any one part of the process. It should be considered as a whole, and he proposed that it be called the American purification process. It is true that the results obtained with the large plants thus far built on this system have frequently been unsatisfactory, but this is due to defects of design and management, not to the system itself.

Dr. Riddell, of London, was called on and said he believed English engineers would do well to give the American filtration system a trial. For some waters he thought it might prove superior to the slow sand system. Recently English cities have been abandoning river sources of supply and going to highland and moorland sources, often more or less colored with organic matter. The mechanical system would appear well adapted to remove this. A further benefit from this removal of vegetable acids from the water would be the lessening of the danger of "plumbesin" (by which term he doubtless referred to lead poisoning).

He thought that eventually filtration would be supplemented by sterilization, and advised engineers to seek to develop some regenerative process by which heat could be applied to the sterilization of water at small cost.

Dr. Kemmler, of Antwerp, said he wished to emphasize the fact that the important action of a sand filter is its biological action. He counseled simplification of the filters. For settling basins he thought the system of alternate filling and emptying of the basins preferable in some respects to the continuous flow system. The rate of filtration should be varied with the condition of the filter and restrictions on waste should be put in force to reduce the volume of water to be filtered.

Prof. K. E. Hilgard, M. Am. Soc. C. E., of the Zurich Polytechnic, said that trouble had been experienced in recent years with the Zurich sand filters. It became necessary to clean them as often as once a week instead of once in four or five weeks as formerly. A "primary" filter had therefore been installed through which the water is passed before going to the regular filters. This primary filter passes water at the rate of about 1 ft. in depth per hour. It is cleaned by a reverse current of water and compressed air, and the latter is found to be a most important factor in efficient cleaning.

Mr. Walter Hunter thought the best proof of the efficiency of ordinary sand filters was the very low death rate and the small amount of water-borne disease in such cities as London. When these results are so satisfactory, too much importance should not be attached to fine points of construction. So satisfactory is the working of the filters that Dr. Thorpe, the chemist recently placed in charge of the London water supply, has abandoned the bacterial analyses, which have so long been kept up, and relies on chemical analyses alone to indicate the working of the filters.

Apropos of the suggestion as to the sterilization of water, he related the story of the scientist, who, at the British Association meeting reported that he had put his children on sterilized food and sterilized water. After a short time they began to droop and he had to put them back on ordinary diet.

Mr. Andrew Johnson gave some particulars of results obtained with polarite filters, and claimed that while polarite was much more expensive than sand, much more rapid filtration was possible with equally good bacterial results.

Reception at the Guildhall.

Those who remember the courtesies extended to American engineers in London eleven years ago, when a large party journeyed thither on their way to the Pa Exposition, may recall that the crowning event of th was the reception tendered to them at the hist Guildhall, the municipal headquarters of the Corporation of London. To be received at the G is an honor reserved, as a rule, for only the m tinguished guests of the city; but this year it wa the good fortune of American engineers to be hon a reception at this famous place.

On Thursday evening the great building was open. The apartments ordinarily used for municip poses were decorated and altered to fit them fo rooms, refreshment rooms, etc., and the most amp vision was made for the evening's entertainment.

In the Guildhall proper, where Sir Douglas and Fox welcomed the guests as they arrived, the string of the Royal Artillery played throughout the eveni In the Council Chamber, a fine apartment octagonal in with high domed roof, a party of students from the Academy of Music gave a concert. In the Library, music was to be heard, an excellent glee club rend dozen or more selections. In the same room wer played selections from the Corporation's collection prints and manuscripts, among which were such quarian treasures as an autograph of Shakespear of the three in existence.

Besides these provisions for the pleasure of the g a loan collection of paintings by living British was displayed in the art gallery, the museum, with large store of relics, was open to the guests, and the building itself, with its quaint architecture, was a interesting study.

Besides the Americans present, cards were sent by the Council of the Institution to many of its own members and to other prominent English engineers, and the whole number attending the reception numbered probably two or three thousand. So ample is the space in the building, however, and so numerous were the attractions in the different rooms, that once past the entrance there was nowhere any crowding, and the evening's entertainment and the cordial hospitality shown will always be a delightful remembrance to every American who was present.

Excursion to Warwick and Stratford.

The concluding, and in some respects the most enjoyable of all the entertainments given by the English hosts to their American guests, was an all-day excursion on Friday, July 6, to visit Warwick Castle and Stratford-on-Avon. A special train of corridor cars was again provided on the Great Western Ry. and the party was again fortunate in having a fine day for its trip.

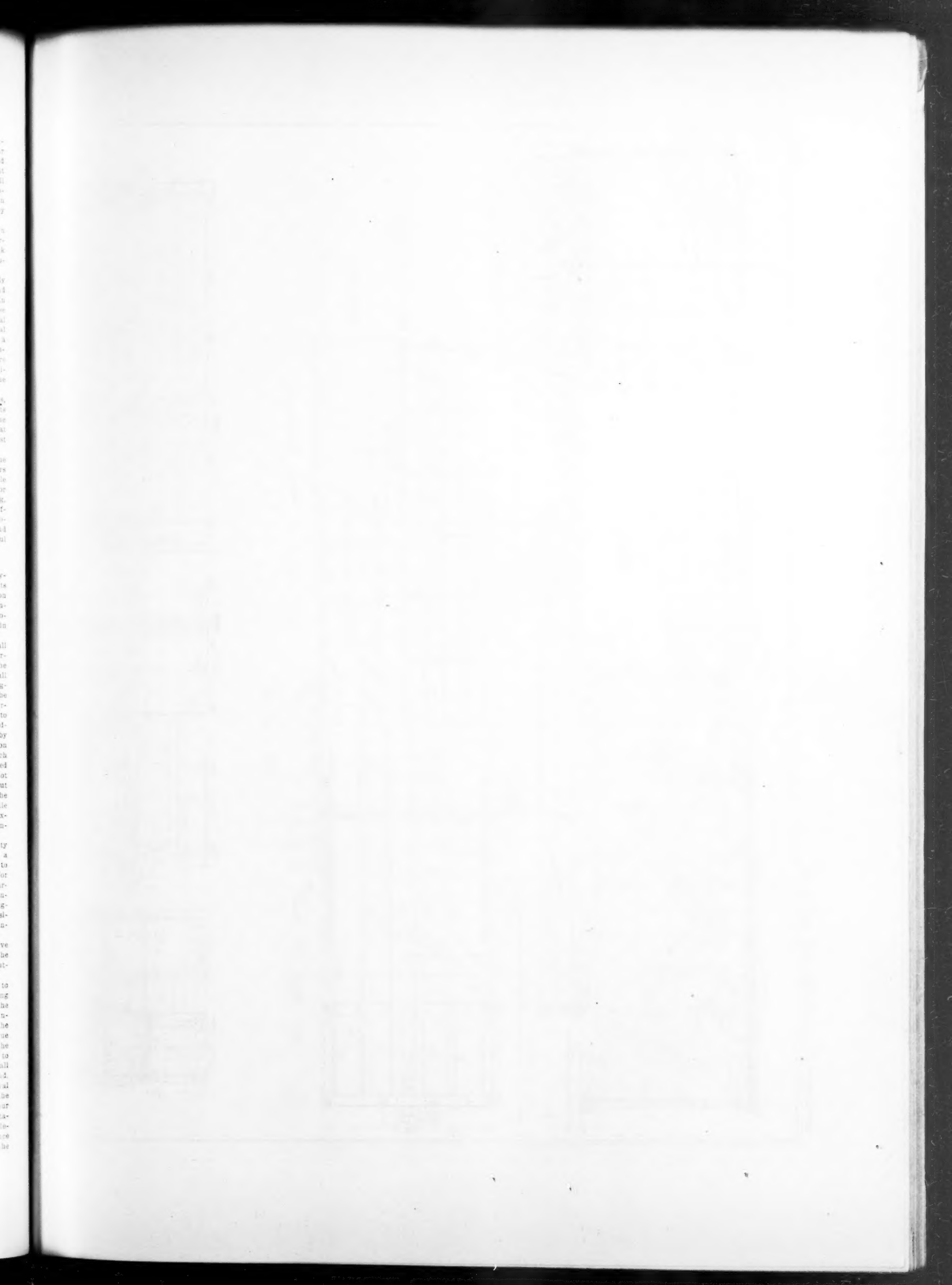
Warwick Castle is perhaps the finest example in all England of the residences of the feudal barons. Certainly nothing more picturesque and beautiful than the winding approach from the gate house at the outer wall to the portals leading to the inner court could be imagined by the American visitors, unless indeed it were the castle itself, with its gray towers and battlements, garlanded with ivy. But even finer and more delightful to the Americans than the castle and its beautiful surroundings was the cordial and hospitable welcome extended by the Earl and Countess to their visitors. They stood upon the porch at the entrance to the mansion, where each guest as he arrived was presented to them and received a pleasant salutation and hand shake. In the castle, not only the State apartments ordinarily shown to visitors, but the living rooms of the family were thrown open, and the party was free to wander through them at pleasure, while the Earl and Countess mingled with their guests, explaining and showing the many treasures of art and antiquity with which the castle is stored.

After a short time spent in this way, the whole party repaired to the Park, where tables had been spread with a bountiful luncheon. When full justice had been done to this, toasts were drunk and hearty cheers were given for the Queen, the President, the Earl and Countess of Warwick, Sir Douglas Fox and the Institution of Civil Engineers. Graceful little speeches were made by Sir Douglas, the Earl, the Countess, and Mr. Wallace, the President of the Am. Soc. C. E., and the expressions of international friendship and fraternity were most hearty.

There was deep regret when the time came to take leave of our gracious hosts and a universal expression that the reception at Warwick Castle had been the most delightful experience of our entire sojourn in England.

From Warwick the special train carried the party to Stratford-on-Avon, where an hour was spent in visiting Shakespeare's birthplace, the Memorial Theatre, and the church in which is the poet's tomb with its famous inscription. It was all very interesting and well worth the visit; but it seemed flat and tame after the picturesque beauty of Warwick Castle, which will long remain in the memories of the Americans whose good fortune it was to be of the party as the most attractive place among all the many beautiful and interesting spots in Old England.

The train then returned to London and on its arrival there final leave was taken of Sir Douglas Fox and the other English engineers who had done so much for our pleasure during the week. Thus concluded the most notable exchange of courtesies between the engineering societies of England and American that has taken place since the entertainment of the Iron and Steel Institute in the United States in 1890.



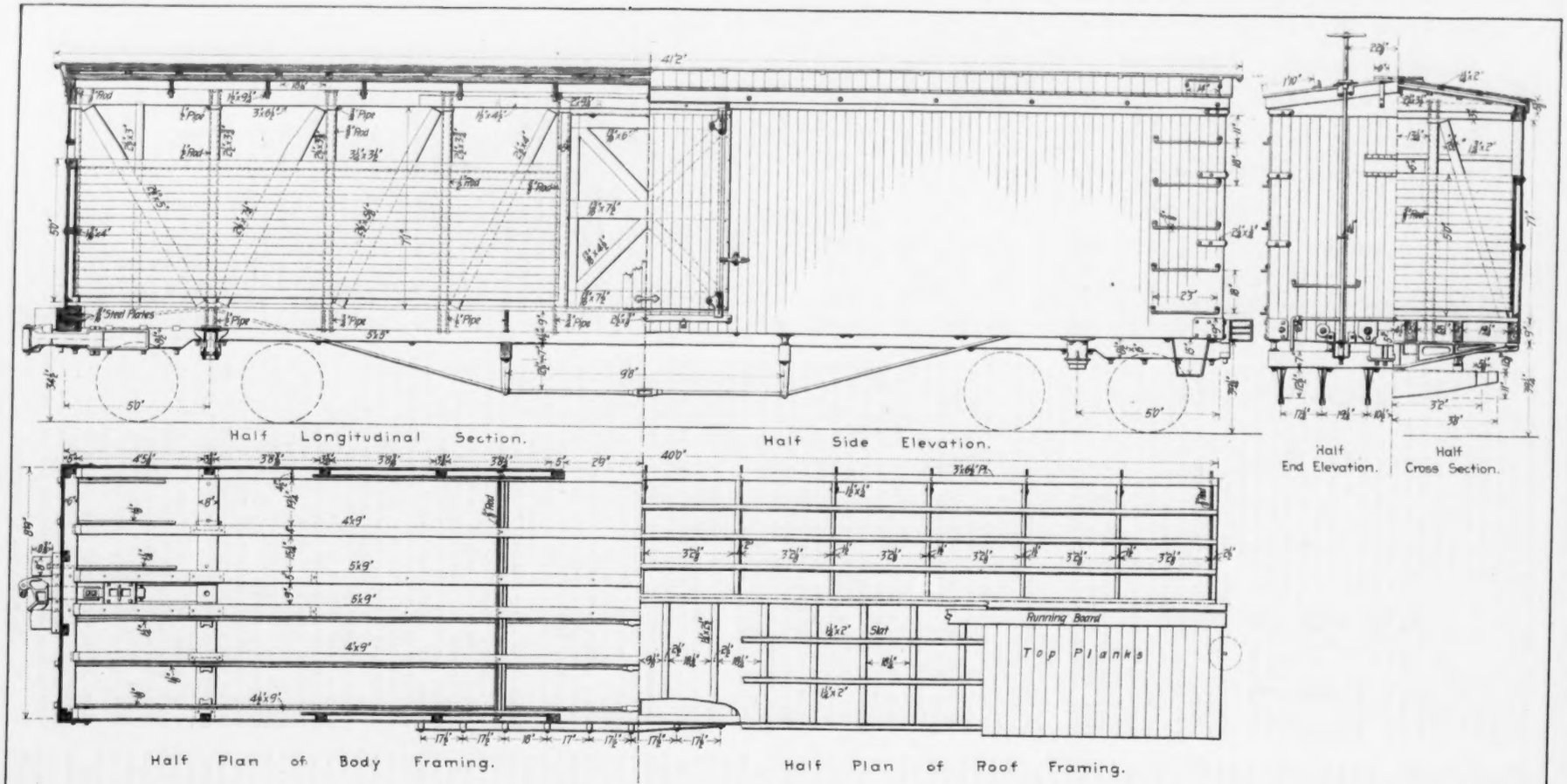
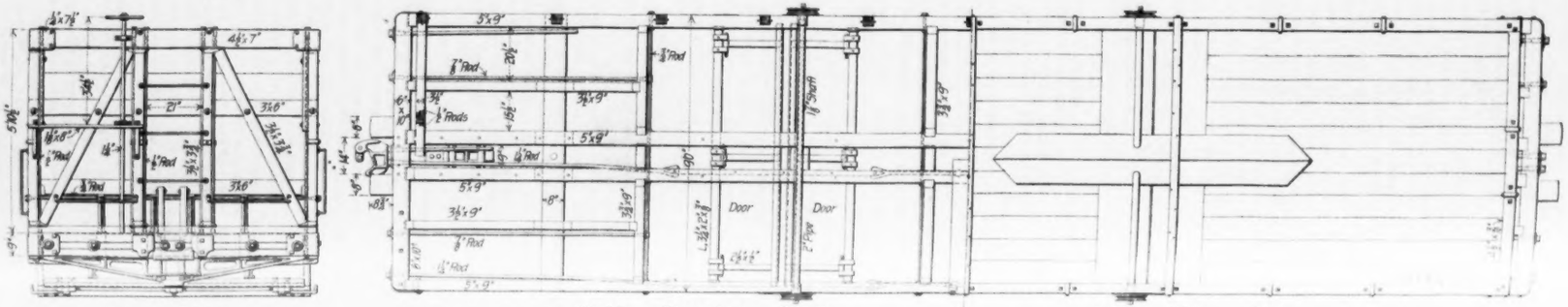

Half Longitudinal Section.
Half Side Elevation.
Half End Elevation.
Half Cross Section.
Half Plan of Body Framing.
Half Plan of Roof Framing.
Running Board
Slat
Top Planks

FIG. 1. BOX CAR.


End Elevation.
Half Framing Plan.
Half Top Plan.
Door
Door

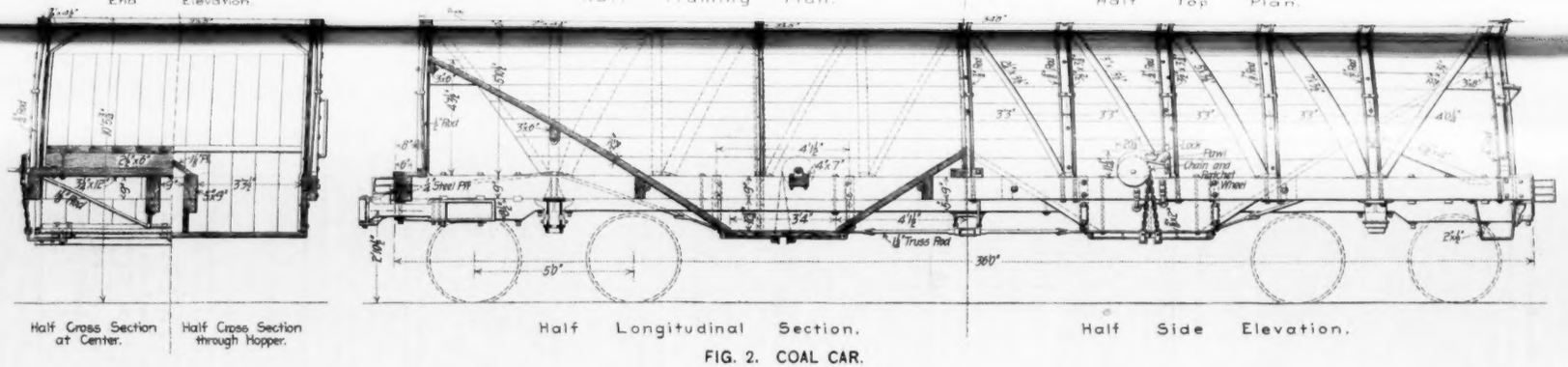


FIG. 2. COAL CAR.

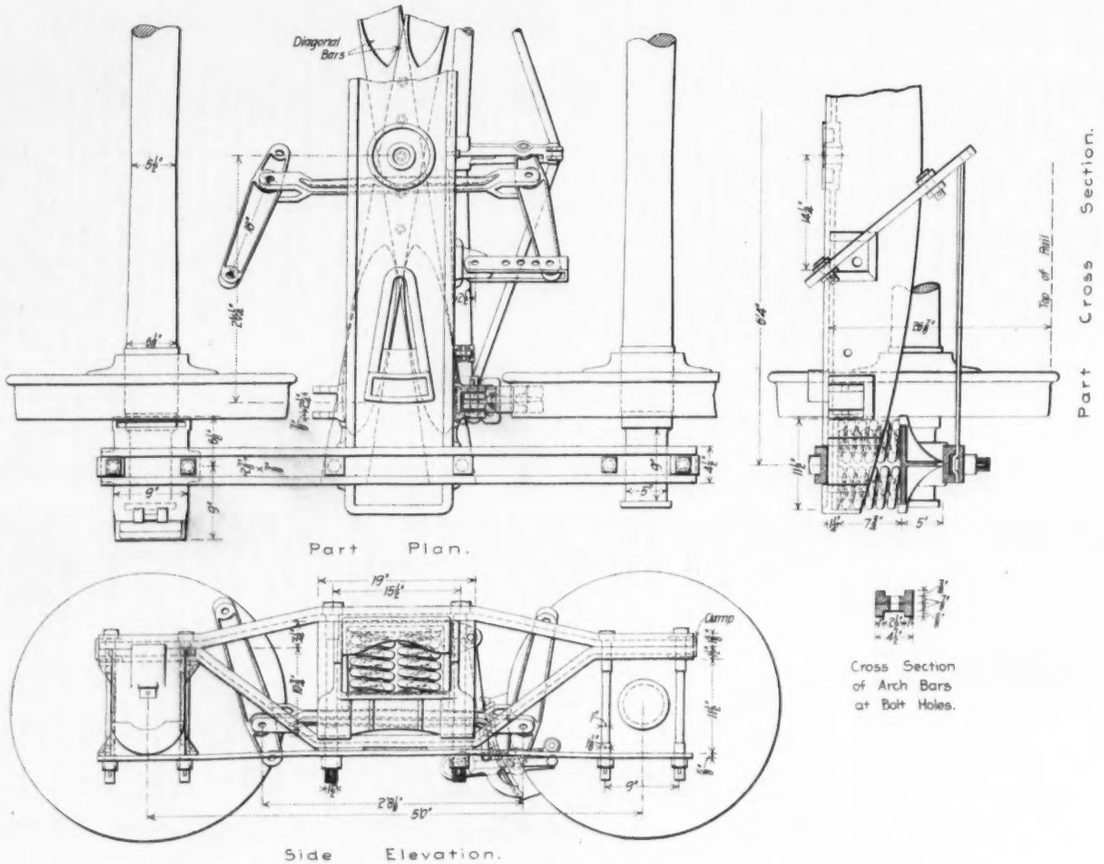


FIG. 3. DETAILS OF TRUCK.

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